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VOLUME 7, No. 3 **MARCH 1955**

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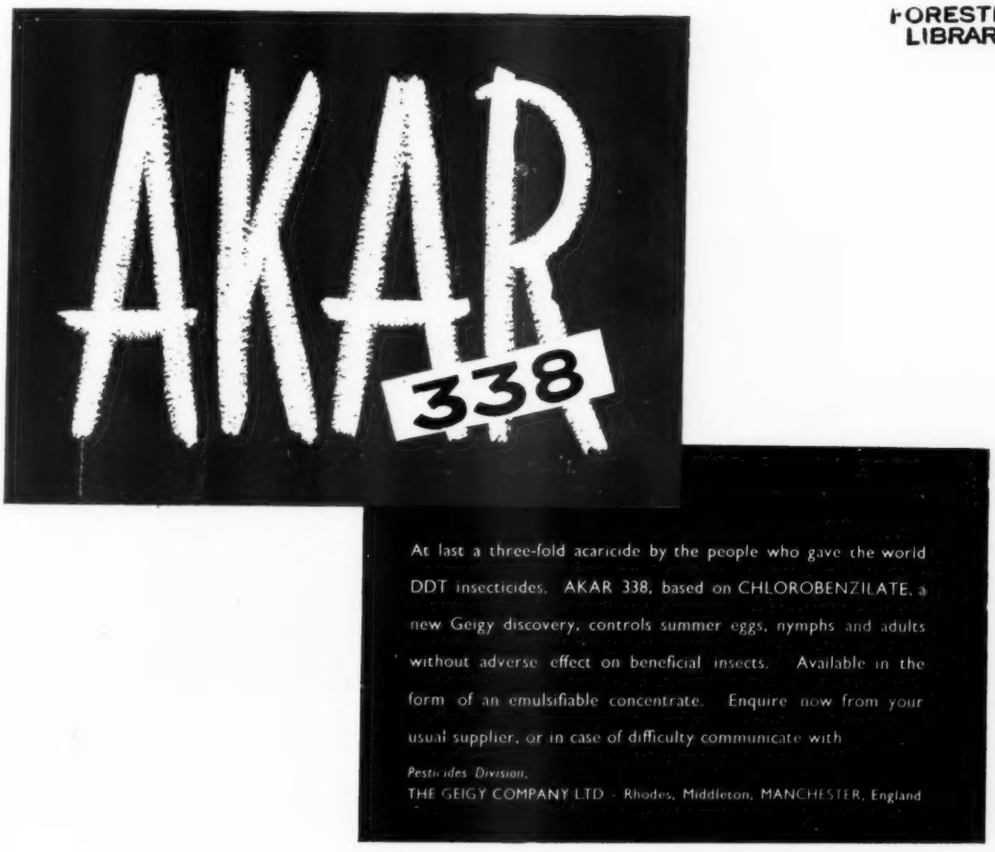
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WORLD CROPS

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Vol. 7. No. 3 — MARCH 1955

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Editorial Comment

The desert blooms

SURELY the Abyan development scheme, small though it may be compared with larger projects in other places, remains one of the more spectacular recent achievements of British administration and agricultural development.

An account of the scheme appears on another page of this issue of WORLD CROPS; here it will suffice to point out that, as the result of work undertaken by the British administration in the Aden Protectorate, an area of some 20,000 acres of dry, rocky and forbidding terrain, producing little or nothing in the way of produce and inhabited by savage Arab tribes whose normal way of life consisted in the relentless prosecution of endless internecine blood feuds, has been converted in the short space of 10 years into a region of peaceful human occupation, producing large crops of long-staple Egyptian type cotton and considerable supplies of badly needed foodstuffs.

The area in question is situated in the south-west corner of the Great Arabian peninsula and lies some 50 miles to the south and east of the town and port of Aden itself. It is practically rainless, but at certain seasons of the year it receives flood water from the better watered mountainous region of the Yemen, which lies to the north-west. These floods are of not inconsiderable volume and are confined to two main watercourses; the area between the two watercourses is cultivable, while the seasonal floods make possible flood or flash irrigation.

In ancient times, the area was fairly extensively cultivated, but, owing to the incessant inter-tribal warfare, it had become largely abandoned and ruinate; little use was made of the facilities for irrigation and until recently the region was virtually non-productive.

In 1943, the British Government in Aden was moved to attempt to improve matters, mainly by reason of the growing shortage of food supplies resulting from war conditions. The first step was an attempt to heal the age-long animosities between the tribes of the region, followed by efforts to induce them to collaborate in schemes for agricultural improvement and production.

These efforts succeeded beyond all expectations; a tripartite economy was set up based upon a development board resembling that established in the Sudan Gezira, on which the Government, the growers and the landowners are represented, working in the first instance with funds supplied from local and Colonial Office sources. Irrigation works were constructed, improved methods of cultivation introduced, ginneries built, tractors and implements made available. In addition, hospitals, schools and other social services were inaugurated and the general conditions of the whole region immeasurably improved. The scheme annually produces some 20,000 bales of Egyptian type cotton and large quantities of foodstuffs. The assets of the scheme were valued at £1,463,710 in September 1953.

The smallness of the scheme must be admitted; nevertheless, it remains an outstanding example of beneficent development in unfavourable conditions by the British Raj—save the mark! It also seems to indicate that even today the Pax Britannica may not have entirely lost its value.

Cocoa supplies

IT is curious that all three of what may be called the beverage crops—tea, coffee and cocoa—are at present in short supply while prices for them range at unprecedented levels. Of the three, the outlook for cocoa seems the most uncertain. It is not an easy crop to grow; its requirements in the way of climatic and soil conditions are narrowly defined, while it is, unfortunately, a prey to numerous pests and diseases. The bulk of the crop is at present produced by peasants in West Africa and Bahia in Brazil, and in West Africa, at any rate, the inroads of disease have put a period to further expansion of production. Writing in the *Financial Times* of November 3 last, Mr. O. J. Voelcker, Director of Agriculture in Malaya and formerly Director of the West African Cocoa Research Institute, expressed the opinion that the next half-century will see no significant expansion of cocoa production in West Africa, although prospects may be somewhat better in Brazil.

It seems obvious that if the increasing demand for cocoa is to be met it can only be by production in countries where it is not at present grown on a large scale. There are a number of these, some of which have already been reviewed in articles in WORLD CROPS. Malaya, in particular, offers attractions and there is, it is believed, suitable land available sufficient to plant at least 300,000 acres under the crop.

Efforts are being made by the Malayan Department of Agriculture to encourage the cultivation of cocoa both as a plantation and a smallholder's crop. At least one estate plantation has already been started and prospects appear encouraging.

It seems, however, certain that in the future the world can no longer continue to look for the production of large quantities of cocoa by smallholders at the very low prices which were usual before the war. If the crop is to be permanently a remunerative one, it

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needs a much greater share of care and attention than it has received in many cases in the past. Therefore, it seems plain that if the required expansion of cocoa production is to be achieved the world must make up its mind to the fact that this is only possible if market prices in future range round a much higher level than they have in the past, though that is not to say that they must remain at the very high levels which they have reached at present.

Farm prices

THE first leading article in the London *Times* of January 24 provokes serious reflection on a number of points. The initial point is that prices at present being paid to farmers in Britain for their produce exceed those paid for the same products to the farmers in the large exporting countries.

It is argued that the low prices of imports may be due to subsidies paid to exporters by the exporting countries, which enable products to be sold for export at prices below those which they realise in their own markets. But, although this may be true in the case of a few products in a small number of countries—wheat from France seems to have been an example recently—it certainly does not hold true in regard to most products of the majority of countries. Thus New Zealand lamb, Argentine beef, Australian and Canadian wheat and Danish bacon are all cheaper in their own countries than are their equivalents produced in Britain. Even in regard to milk, the stepping up of the production of which in Britain has been so much publicised and belauded, it must not be forgotten that milk today in Britain is much dearer than in other countries.

Since the war, Britain's agricultural policy has been aimed at expanding farm output, originally, no doubt, to counter the threat of starvation as the result of enemy action, but latterly in pursuance of the principle inherent in the resolutions of the Hot Springs Conference on Food and Agriculture in 1943, *viz.* that every government would endeavour to supply from its own resources as large a proportion as is economically practicable of nutritionally satisfactory food supplies.

This has led to the Agriculture Act of 1947 and thereunder to the payment of large sums in subsidies and grants for agricultural production. That this should have led to the raising of prices is indeed not remarkable, but while there is every indication that the most efficient producers are doing their best to reduce continuously their costs of production there is little doubt that many cases exist in which this does not apply.

In a democratic country like Britain, with the prospect of an election looming ahead in the immediate future, there is no doubt some risk of the old conflict between the farmer and the man in the street on the subject of cheap imported food once more assuming undesirable prominence. There is, unfortunately, widespread in Britain a series of sectional convictions in different groups of workers that they in particular are suffering from injustices in the maldistribution of wealth exceeding in magnitude those of other groups and that in these circumstances any action is permissible to obtain redress. This has led to the long series of strikes and wages adjustments of late years, with consequent increases in costs of production, including, it must not be overlooked, agricultural production.

No doubt at present the outlook is favourable: production is increasing in an expanding world economy. Let us hope that in the presence of all these mutable factors it will be possible to maintain policy on sufficiently stable lines to ensure that development continues on the present even course. It cannot, however, be overlooked that increasing costs of production resulting from increased demands for remuneration by workers can possibly have one undesirable result, *viz.* the pricing of British goods out of the world's markets.

Irradiation

THERE is nothing new in the idea of killing micro-organisms with forms of atomic radiation. It was observed that cathode rays could destroy bacterial organisms as long ago as 1905. What is now being called 'irradiation' is much discussed currently as a method of food preservation because radiation from waste products from atomic energy piles seems capable of transforming its economics. However, it seems unlikely that irradiation will displace traditional methods of long-term food preservation for some years. Radiation liberates free radicals of an oxidising nature and at present this creates formidable side-effect problems, such as loss of vitamins and the development of serious off-flavours. The more probable field for irradiation in the near future is in short-term preservation, using low energy radiation to give a surface sterilisation. If there is little penetration, the troublesome side-effects are negligible.

A particularly interesting example of this is the use of radiation to repress sprouting in stored potatoes. Potatoes irradiated at the University of Michigan have since been stored for a year at 48°F. without any development of sprouting or of rotting. Thus, the maximum natural period of safe storage has been at least doubled; and there are indications that storage for longer periods than a year would still be free from the sprouting risk. This seems superior to the best results that can be secured by using growth-inhibiting chemicals. However, the irradiation method would involve the construction of special centralised plants so that

potatoes for store could be passed on conveyor belts through radiation chambers.

Costs might be cheaper if machine-produced radiation was utilised instead of radiation from atomic energy by-products, for the older-fashioned radiation machines can be turned on and off and much less protective shielding would be needed in the construction of the plant. In either case, the probable costs of irradiation will not be outside the reach of practical economics, having regard to the value of the extended lifetime of potatoes in store. Indeed, the economic importance of the potato crop is heavily dependent upon its storage life—in that respect it must be ranked with the basic cereals.

Synthetic rubber substitutes

A COMMENT in the *India Rubber Journal* of November last (**37,** No. 21) calls attention to a new problem which has arisen in regard to the production of synthetic rubber substitutes. It appears that, despite the large amount of money and research effort which has been injected into the production of substances of this description, notably in the U.S.A., and the considerable successes achieved, man has not so far succeeded in producing a polymer possessing the low heat build-up and low hysteresis of natural rubber. This property of low heat build-up is particularly important for rubber for the giant tyres of heavy lorries, heavy float transporter vehicles, etc. If it was possible to produce a synthetic elastomer possessing these desirable properties, it would no longer be necessary for the U.S.A., for example, to maintain and carry large stockpiles of natural rubber.

So far efforts to produce synthetic rubber substitutes have been independent of biological methods and have had their most important application in relation to materials often derived from mineral sources; they have become to an extent appanages of the oil industry. But now apparently the Americans, ironically enough, are seeking a solution to the problem by a study of the formation of rubber in the plant itself. To find out, so to say, how the plant ' does the trick ' and to apply the knowledge so gained to the development of a synthetic elastomer compound possessing a low heat build-up like natural rubber.

With the title ' The Biosynthesis of Rubber,' a paper under the joint authorship of James Bonnor, Marion W. Parker and Juan G. Monternoso has recently appeared (*Science*, **120,** 549) which reports that two novel approaches to the development of low heat build-up rubbers by natural processes in the living plant are now under way. The two investigations are interrelated. One, at the California Institute of Technology, has to do with the study of rubber synthesis by plant enzyme systems, while the other, which is being carried out by the United States Department of Agriculture, has to do specifically with the synthesis of rubber by the para rubber tree, Hevea. In addition, the U.S. Department of Agriculture is collaborating actively in the production of C_{14}, labelled natural rubber in the Argonne National Laboratory, Illinois. Some progress has already been made regarding the identification of the monomer from which rubber is synthesised in the plant; the evidence suggests that this may be beta-methyl crotonic acid or a derivative of it.

Many years ago it appears that Mr. F. D. Ascoli, in a memorandum on research into the improvement of natural rubber to meet the challenge of synthetic, made some suggestions regarding the possibility of modifying the characteristics of the rubber globule by inoculating young trees with appropriate chemical reagents to produce types of rubber suited to particular requirements.

No developments appear so far to have followed this suggestion, but with the *India Rubber Journal* we are inspired to hope that the American work referred to above may lead to a flood of light being thrown on these obscure biological processes and that in due course we may be able to look forward to a range of modified rubber products all tailored to meet the most exacting requirements of the manufacturers, but which are not the outcome of the labours of the physicist and the chemist alone working on dead inert materials, but of a group of scientists working on the living medium of the plant itself.

Britain's pilot farms

THE Dutch idea of pilot farms as demonstration centres is proving highly successful in Britain. A pilot farm remains privately owned, but the farmer carries out advice given to him by agricultural advisory officers, advice that might well involve a somewhat radical reorganisation of previous policy. One such farm in the West Country is now producing £39.5 in output value per acre compared with £22.9 per acre when it first became a pilot farm five years ago.

This remarkably rapid improvement has been achieved without any major capital investment. Milk production, especially in winter, was made the main enterprise; milk recording was initiated; the herd was improved by selling the least productive cows and introducing new in-calf heifers, and a maximum acreage of cash crops was gradually worked into the annual farm programme. This naturally meant raising farm costs, but, in fact, the rise was only a matter of £5.8 per acre, a small premium to pay for an output increase of nearly £17 per acre.

In 1949, this farm produced a profit of just under £3 per acre; in 1953, the profit was over £13 per acre.

Even in two years the profit per acre was more than doubled. The principal increase in costs was for ' seeds and fertilisers.' Formerly expenditure under this head was only £1 per acre; now it is £2 12s. per acre. No doubt most of this increase must be attributed to higher rates of fertiliser application, especially to grassland.

The farm, formerly running at only about two-thirds of the economic efficiency of farms in its area, is now a centre for farm walks in the summer and discussion meetings in the winter. It has become the headquarters of a group of about 50 farmers who discuss their own farms' problems in the light of what has been achieved at the pilot farm. Can any other means of agricultural education be more effective? It seems doubtful, for farmers, more than most people, are staunch supporters of the idea that a pound of practice is worth a ton of theory.

The pilot farm scheme in Britain is still very young, and it takes more than five years on most farms for the fullest benefits of replanning and technical advice to emerge. If this kind of result has been reached in five years, the owners of pilot farms in another five years' time are likely to be busier than landed dukes in showing visitors round their ' estates.' The same idea was successfully used during the war years, when one or two allotments in public parks and other allotment centres were selected as demonstration plots.

Systemic insecticides for cotton plants

PROMISING results with new systemic insecticides on several cotton insect pests are reported by entomologists of the U.S. Department of Agriculture. All consist of organic chemicals and are absorbed into a plant and carried by its sap to make the stalk and foliage and, in some instances, the fruit, toxic to feeding insects.

Systemic insecticides are already familiar to some cotton growers; they have been used to control such pests as aphids and spider mites, which feed on sap. However, in laboratory tests conducted by entomologists of the Agricultural Research Service and the Texas Experiment Station of the Department, the new systemics proved lethal not only to these sucking insects, but also to species which chew the plant, such as the weevil and cotton leafworm. When cotton seed was treated with the new systemics and planted, some of the chemicals gave protection against thrips, aphids and spider mites for more than a month.

The two most promising compounds are known as L-11-6 and 12008. Their chemical names are, respectively, O,O-diethyl S-ethyl mercaptomethyl dithiophosphate and O,O-diethyl S-isopropyl mercaptomethyl dithiophosphate. Other mercaptomethyldithiophosphate compounds proved toxic to chewing insects in these tests, but L-11-6 and 12008 were found to be the most effective.

Entomologists emphasise that, despite the excellent results of these early tests, much more has yet to be learned about these systemics before they can be recommended for use to the cotton producer. It will be necessary to discover the best way to treat the seed with the materials so that germination will not be lowered, how the chemicals affect plant growth, and whether the insecticides tend to build up dangerous residues in the plants.

A new vitamin C crop

POST-WAR vitamin research has given the world a new commercial crop, the acerola cherry of Puerto Rico. In 1946, workers at the School of Tropical Medicine in Puerto Rico discovered that the fruit from the wild acerola trees was the richest known source of vitamin C—the juice from the acerola berry contains 80 times as much of the vitamin as orange juice. Plans for development were passed to agriculturists but the attempt to domesticate this wild tree ran into many obstacles, notably its poor germinative capacity. However, these problems were eventually overcome and the commercial growth of the bushy acerola tree is now sufficiently far advanced in Puerto Rico for factory arrangements to extract and process the juice to be started.

The crop is likely to become a useful cash crop for small growers there. Also, every schoolyard has been planted with acerola trees in the hope that a daily issue of two acerola cherries can be given to the native children. However, most of the crop Puerto Rico seems likely to grow in the future will be exported to the United States as canned juice for fortifying other fruit juices with vitamin C.

It is possible that the new crop and its associated canning industry may have only a temporary period of success. Will the canned juice in fact be cheaper than the fairly easily made synthetic vitamin C (ascorbic acid)? At present this economic comparison does not matter much. The American Medical Association frowns on synthetic additives though, so far as vitamin C is concerned, this attitude is somewhat reactionary. It requires no more than a change in front by the A.M.A. on this particular matter and the market for acerola cherries and their juice might vanish swiftly. In other countries there is little prejudice against the use of synthetic vitamin C as a fortifying additive for food products.

Problems Involved in the Extension of Maize Cultivation into Northern Temperate Regions

JOHN L. HARPER, D.PHIL.

Department of Agriculture, Oxford University

The introduction of hybrid maize varieties in the U.S.A. has greatly increased the yields of the crop. Of late years much work has been done on the problem in Europe. In this article Dr. Harper reviews the subject and the progress made in recent years.

MAIZE is generally accepted as of New World origin and it is commonly claimed that it was first introduced to Europeans by two Spaniards who were sent by Columbus in 1492 to explore the interior of Cuba. They brought back reports of 'a sort of grain which they call maiz which was well tasted, bak'd and made into flour.' Recently, pots decorated by rolling a maize cob over the wet clay have been found at Ife, Nigeria, and these have been dated at approximately A.D. 1100. It has been suggested that the crop may have been first introduced through Arab-Negro contacts with the Americas, beginning at about A.D. 900. This plant, which is known only in cultivated forms, is now more extensively distributed over the earth than any other cereal crop and is exceeded in total acreage by wheat alone. The plant exists in a great range of forms and habits, in many cases associated with local climatic conditions or cultural practices. From this mass of genetic material new strains have been bred which are suited to new areas and, in particular, inbreds have been produced which have been selected for especially desirable qualities. From these inbreds, hybrids are synthesised which combine not only the selected qualities of the parent inbreds, but also associate this combination with hybrid vigour. One of the most striking possibilities opened up by modern breeding and seed production techniques in America and Canada has been the spread of maize cultivation further north—into regions of lower temperature and shorter growing season than is characteristic of the main corn belt of the U.S.A. This is strikingly shown when the average maize production in 1940-49 is compared with that in 1920-30 in the corn belt and the northern states of the U.S.A. Over this period the production of Iowa and Illinois increased by 21.6% and 27.3% respectively, whereas that of Wisconsin increased by 54.3%. Not only is the acreage devoted to maize in the northern states increasing very rapidly, but productivity is keeping pace with the extension of the range. In 1953, the average grain yield in Wisconsin exceeded that of any other state for the first time in history.

Maize growing in Europe

In Europe, the cultivation of maize as a grain crop is important in the Danube basin, U.S.S.R., Italy and Spain. All of these maize-producing areas lie about 5° further north than the corn belt of the U.S., with the exception of Spain, which is about the same latitude. Although the acreage of maize planted in these areas was low compared with that of U.S.A., Roumania had become the world's second largest exporter of maize before the 1939-45 war. Portugal is an important European maize producer and maize growing is now a very significant part of agricultural practice in parts of France, the Swiss Tessin and very recently Southern and South-Eastern Holland.

The main European maize-growing areas and the U.S. belt have summer temperatures of 70°F. or above and winter mean temperatures of above 50°F. The approximate climatic requirements for high yields of the crop are summer temperatures of 75°F. with night temperatures of 58°F. and a growing season of 140 days. However, these limits are wide generalisations and strains exist which grow 20 ft. tall and require 300 days to mature, as well as dwarf strains reaching 2 ft. in height which will mature in 60 to 70 days. European maize breeders have been conducting trials with seed of American hybrids which range from Wisconsin 1600, which requires 70 days to reach maturity, to Dixie 11, which requires about 150 days. (These 'maturity classes' refer to the performance of varieties in Minnesota, and these values should be doubled to give reasonable expectations for Northern Europe.)

In general, the height, number of tillers produced, weight and number of leaves are correlated with the length of the growing season required for maturity. The growing season is usually determined as the interval between the last killing frost of spring and the first killing frost of autumn. Varieties differ in frost resistance, and so the potential growing season for maize in one area may differ markedly from one strain to another. Some strains are killed by exposure to 45°F. (chilling injury), while others can withstand exposure to 32°F. for some hours without suffering damage. Indeed, Tarahumare Indians of Mexico grow a strain of corn which is said to withstand severe frosts, even after it has reached a height of 2 ft.

Early planting

When the length of the growing season is a serious limitation on the

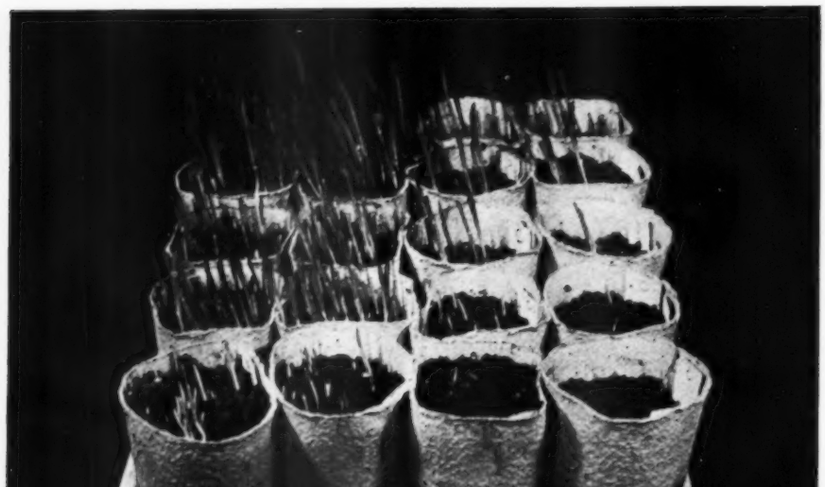

Fig. 1. Cold testing of maize. Virginian White Horsetooth maize sown at 50 seeds per pot and exposed to 5°C. (41°F.) for 10 days and subsequently incubated at 20°C. (68°F.). The two rows of pots on the left were sown with grains which had been treated with a commercial fungicide containing TMTD

growth of maize, there is an obvious advantage to be gained from early planting, so that none of the possible growing season is missed. However, establishment from early plantings is often unsuccessful because the grains rot or the seedlings wilt and die from the attacks of soil-borne pathogens, even in the absence of killing frosts; the effective growing season may therefore be much shorter than the interval between the last and first frosts.

Maize grains sown in soil at temperatures below 32°F. may be little damaged by exposure to this temperature provided that a period of higher temperature has not occurred between sowing and freezing, but at temperatures between 32°F. and 60°F. a thin stand results from rotting of the seed and within this temperature range the mortality is roughly proportional to the length of time for which the grains have been exposed in the soil. Moreover, germination of most maize varieties does not occur below 50°F., although some of the American hybrids, such as Wisconsin 275, germinate very slowly at this temperature, and claims have been made that some Jugoslav varieties germinate at 41°F. For most purposes, however, the growing season for maize may be redefined as the time between the soil reaching a temperature of more than 50°F. (or the last killing frost if this occurs later) and the first killing frost of autumn. It follows that the effective growing season can be lengthened if varieties are bred capable of germination and growth at lower temperatures. This aspect of the problem has been given little attention by breeders and may be worthy of further study. The effective growing season can also be lengthened by breeding maize varieties which are resistant to grain decay and seedling blight.

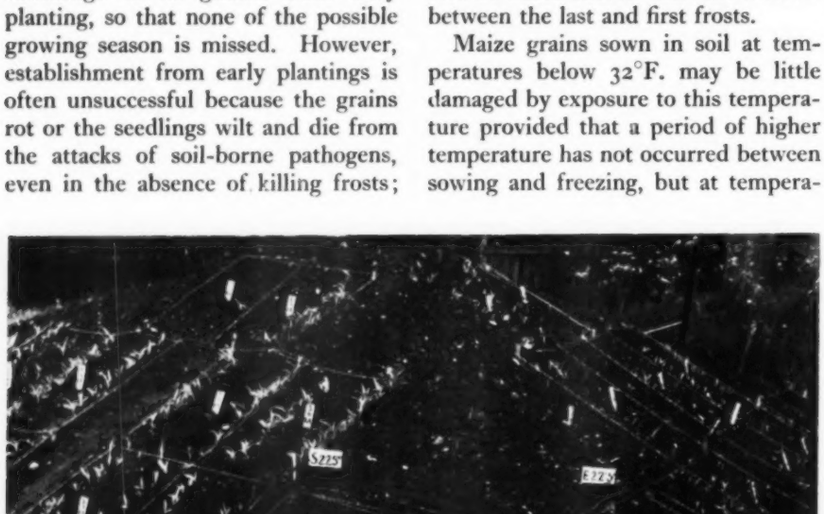

Fig. 2. A soil mound of 22.5° slopes—facing N, S, E and W—sown with several varieties of maize at different planting dates to determine the influence of aspect on germination and rate of emergence. South and east faces are shown here. A continuous soil temperature recorder is shown in operation on the site of the experiment

Disease resistance

Resistance to seed decay and seedling blight may be associated in part with the ability to germinate and grow at low temperatures, for there is evidence that the pathogens causing seed and seedling mortality are most destructive in soil environments which are unsuitable for optimal host growth. Other aspects of seed and seedling resistance to early rotting and blights are centred in mechanical features of the grain, such as pericarp structure, or biochemical features, such as the content of carbohydrates and soluble proteins. The inheritance of this disease resistance is most complex because resistance may be expressed in different ways at different stages of growth. In general, it is found that the flint corns are more resistant than the dents and that well-ripened grain is better than that which has been partially ripened or artificially dried.

Cold germination tests

Standard laboratory germination tests give values for seed viability, which in the case of maize are in no way reflected in the stands obtained in the field. The standard tests give a

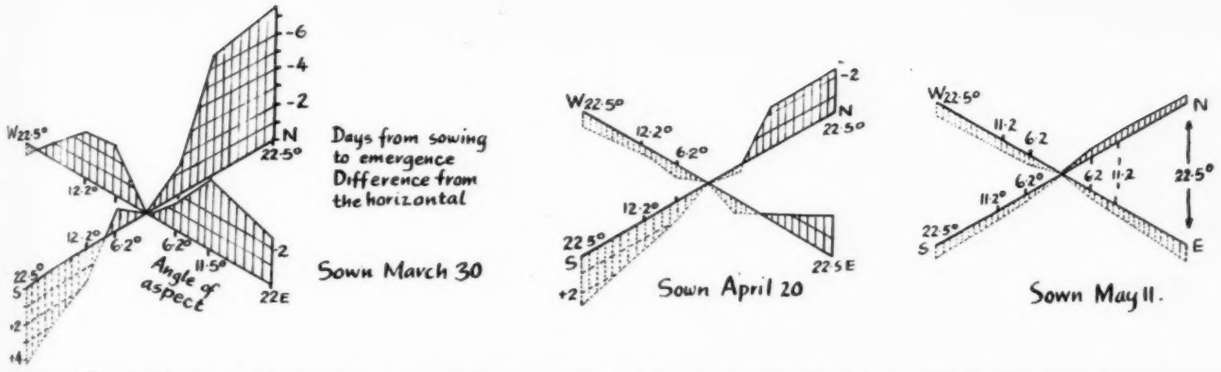

Fig. 3. The influence of aspect and planting date on the emergence of maize. This diagram shows the advantage or disadvantage in days, more or less, required for maize emergence on slopes facing N, S, E and W. The influence of angle or slope is shown along the lines of the oblique cross, starting from the intersection which represents horizontal ground and the angle of slope increasing outwards from this intersection. The number of days required for emergence on unfavourable slopes in excess of the number required on the flat is projected vertically upwards. The advantage gained on favourable slopes is expressed vertically downwards (dotted lines)

very optimistic estimate of the field stand and this is particularly true when the grains are sown in the cold wet soils of a north temperate spring. Specialised 'cold tests' have therefore been developed for maize which seek to imitate in the laboratory the germination hazards which are encountered in the field.

In these tests, maize grains are sown in damp soil and exposed to a temperature of 41°F. (the temperature chosen varies at different testing centres) for a week or more and then transferred to a higher temperature suitable for rapid germination (see Fig. 1). The germination and emergence obtained after such a test are closely correlated with emergence in the field.

Tests of this sort have exposed many of the causes of poor field stands, and of great importance among these is the demonstration that harvesting and threshing procedures may cause chipping or cracking of the grain coat, which greatly predisposes the grain to rotting in the field but does not affect germination in the standard tests. The more hazardous the conditions of germination in the field (in particular the wetter and colder the soil) the more important it is to ensure that the grain is undamaged. The type of drill used for planting maize may sometimes be a source of damage to otherwise good seed, for, although commercial maize drills cause negligible damage to the grains, smallholders who use makeshift apparatus for sowing, such as some types of mangold drill, may obtain poor stands from excellent seed, owing to the damage done to the pericarp while passing through the drill.

Seed pre-treatment

Maize grains may be protected to some extent from grain and seedling rots by treatment of the grains with a suitable fungicide before sowing. A fungicide dressing will give at least partial protection against entry of the soil-borne organisms responsible for rotting. For this purpose, the relatively new TMTD dressings (containing tetra-methyl thiuram disulphide) have proved very suitable in Europe and America; they are applied as a dust or as a slurry, which is probably better.

The 'cold test' provides an excellent way of testing the degree of protection given by different commercial formulations of fungicides and it is clear that the improvement of fungicides, coupled with the breeding of varieties of maize capable of germination at lower temperatures, will greatly help in extending the range of maize cultivation further north.

Bird damage

Field stands are often drastically reduced by rooks, which unearth and eat grain before it has germinated or emerged. There is no completely satisfactory way of preventing this damage and improvements in bird scarers or bird repellents are urgently needed if maize is to become a safer crop for many farmers.

Choice of planting sites

The choice of site is very important when maize is to be grown. As the soil temperature at the time of sowing markedly influences the rate of germination as well as the ultimate stand obtained, sites facing south or west should be preferred to other aspects. Experiments at Oxford by J. W. Ludwig have demonstrated the very great influence that small differences in aspect may have on the emergence and ripening of maize. On the south face of artificial mounds of 22.5° elevation, Virginian White Horsetooth maize produced fully ripened grain, although it is a variety from the deep south of the U.S.A., and in Oxford meets with a day length much longer than that to which it is accustomed. This variety had not ripened grain before when sown on the flat. The diagram shows clearly the influence of aspect and elevation on the time taken for maize to emerge (Figs. 2 and 3).

Day length

The length of day is another factor which influences the rate of development and ripening of maize. Over a long period of maize cultivation, races have been evolved which are adjusted to the day length characteristic of particular latitudes. In general, the shortening of day length from that to which a variety is adapted results in earlier flowering and decreased leaf area. This feature is made use of when choosing varieties of maize for use as

fodder crops, for varieties from the Southern U.S.A. will have flowering delayed by the long days of northern temperate regions and will produce excess leafage. For this reason, Virginian White Horsetooth maize became a popular green fodder and silage maize in Great Britain, although it is now being replaced by hybrids.

Rainfall

Maize requires plentiful rainfall throughout its growth, except that very wet conditions at the stage of establishment may lead to excessive rotting of the grain in the soil. There is also evidence that grain sown when the soil is too dry to allow immediate germination may suffer from rotting by soil borne organisms and thus be incapable of germination when rain comes. These conditions are only likely to occur in the southern and eastern parts of Europe, but may be a frequent source of failure in monsoon regions where maize is planted before the rains, which sometimes come late.

Apart from these hazards in early establishment, the most sensitive part of the life cycle occurs at the silking phase, when drought may lead to serious losses. Where rainfall is limited, irrigation may allow the crop to be cultivated; irrigation is the normal practice in the Po valley, the major maize-growing area of Italy.

Choice of varieties

In the choice of varieties suitable for Northern Europe the American hybrids have been extensively tested. Early tests were made by G. E. Blackman in England and after the 1939-45 war the Food and Agriculture Organisation of the United Nations organised international co-operative maize trials in many European countries and organised conferences of maize breeders in Europe. This scheme has enabled European research workers to test varieties, usually hybrids of maize from areas climatically analogous in the U.S., alongside local, usually open pollinated, strains of maize.

FAO and OEEC (Organisation for European Economic Co-operation) have helped in the organisation of tests in countries ranging from Norway to Egypt and from Portugal to Turkey, and American breeders have been most generous in the provision of hybrid seed for these trials. The tests

Fig. 4. Goudster, a Dutch open pollinated maize selected from flint - dent cross, growing in varietal trials at the University Field Station, Department of Agriculture, Oxford

have most frequently shown the superiority of the American hybrids over local open pollinated races and the hybrids are now becoming rapidly established in Europe.

It is, however, greatly to be hoped that the spread of American hybrid maize over Europe will not result in the loss of local strains, with their long selected gene combinations, carrying adaptability to local conditions. In time, inbreds carrying desirable qualities should be developed from the European open pollinated varieties and these, together or in combination with American inbreds, may then be used to give new and further improved hybrids.

European maize varieties

The indigenous varieties of Northern Europe are early flint maizes, with their well-known weaknesses. The use of flint x dent hybrids made it possible to envisage grain maize as an important crop for these areas.

In Northern Europe, the present aim seems to be the production of flint x dent hybrids and open pollinated varieties derived from such crosses (*e.g.* Goudster in Holland, Fig. 4). This raises the interesting problem of where to obtain suitable sources of dent material. There is a wealth of good flint material in Europe (so far flint x flint hybrids, *e.g.* W.1600, have not proved successful), but as dent material is relatively rare it seems likely that further steps will have to be taken to collect and conserve local European varieties of dent maize for incorporation into the breeding programmes if real advances are to be made.

The use of American hybrid material should perhaps be regarded as a temporary step in maize improvement in Europe, to be followed by the development of new locally adapted inbreds and hybrids from the long-established open pollinated maizes of Europe.

Maize for forage and ensilage

American hybrid maize is not only replacing local strains for grain production, but also for use as a green forage crop and for ensilage. Maize has certain obvious advantages as a green fodder crop in that it has a peak of production at a time when the growth of pastures has temporarily slowed down. It may then be fed green or ensiled. As early as 1875 a farmer in a barren district of Sologne in France was having remarkable success with maize as a silage crop. The crop ensiles easily, having a high available carbohydrate content which allows rapid fermentation. There is one disadvantage to the crop for this purpose, namely, that the protein content is low and needs supplementing in feeding. Silage is frequently regarded in Europe as a means of conserving protein-rich food, but in Wisconsin maize silage is widely used to provide a maintenance ration. It is perhaps desirable that investigation be made of the possibility of combining maize with other crops which can be ensiled with it to improve the quality of the silage or, better still, to discover a suitable legume for cultivation as a mixed crop with maize.

It has already been pointed out that varieties which require short days for good grain production and ripening will often make good silage varieties in regions of longer days. Recently, under the stimulus of the FAO programme, hybrids have been tested for silage in Northern Europe and have

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The Cocoa Industry of Bahia in Brazil

D. H. URQUHART, B.SC. (AGRIC.) and G. A. ROSS WOOD, B.A., D.T.A.
Cadbury Brothers Ltd.

The cocoa industry of the state of Bahia in Brazil is the second largest in the world, coming second to that of the Gold Coast in West Africa. Until recently the information available concerning this industry was meagre despite its great importance. Recently, the authors of this paper visited the country under the auspices of Cadbury Brothers, Ltd., and their report, which is reproduced in slightly shortened form below, records the results of their observations. The information is of considerable interest and WORLD CROPS *is deeply indebted to Messrs. Cadbury for permitting it to be made available to our readers.*

COCOA production in Brazil is centred almost entirely on the state of Bahia, and in that state it is by far the most important export. Bahia is one of the larger states of Brazil, having an area of 214,000 sq. miles and the population in 1950 was estimated at nearly 5 million. It is said that a Frenchman, Frederick Warneau, brought the first seeds of cocoa to Bahia from Para in the Amazon Valley in 1746.

Cocoa growing was slow to develop, exports in 1890 being only 3,500 tons. Soon after this date production began to increase and by 1934 reached 100,000 tons. Since then there has been no marked increase, the average production for the past 20 years being 120,000 tons. There have been fluctuations in output, due mainly to variations in rainfall distribution in certain years. In the favourable season of 1946-47, the large crop of 151,000 tons was harvested, but this was followed by the prolonged drought of 1947-48, when the crop amounted to only 98,000 tons.

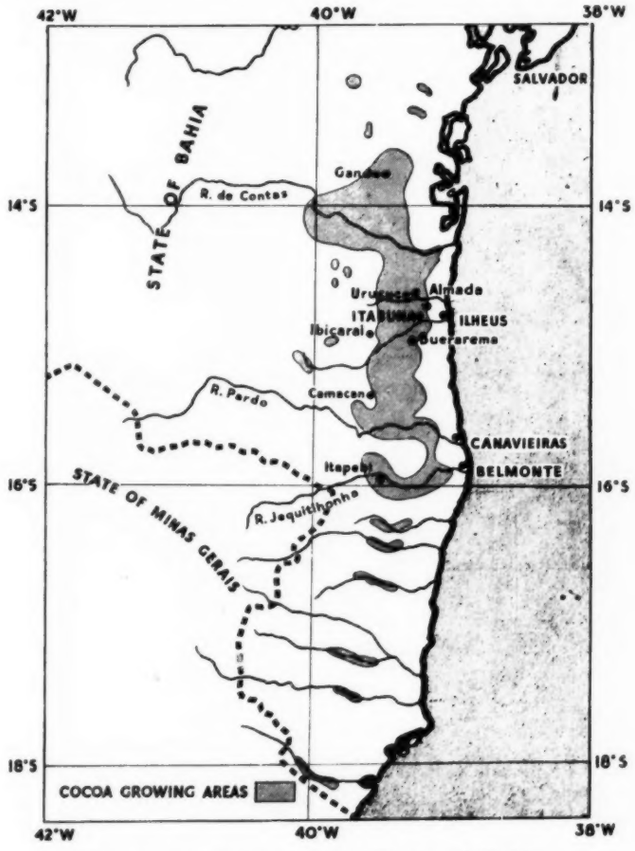
The cocoa zone

The main cocoa-growing area is a fairly narrow belt running from north to south along the coast. It is some 175 miles long and has its centre at Itabuna, 20 miles inland from the port of Ilheus. The soils along the coast are generally unsuitable for cocoa and the plantations are not to be found within 10 miles of the coast. The width of the cocoa-growing area varies, but the most westerly plantings are within 75 miles of the coast, climatic conditions further west being unsuitable for cocoa.

South of the main area there are small isolated patches of cocoa on the banks of several small rivers.

Climate

The rainfall varies between 48 and 87 in. per annum. The highest rainfall occurs on the coast in a fairly small area around Ilheus. At Uruçuca the rainfall is 77 in., while at Ibicarai on the western edge of the zone it is 57 in. The rainfall decreases fairly rapidly further inland. To the north of the cocoa zone the climate is drier and the rainfall is less reliable; to the south there is a broad belt of land



The cocoa zone of the State of Bahia

receiving 40 to 60 in. Normally the rainfall is fairly well distributed throughout the year. The wettest months are usually March and April, November and December.

The cocoa zone is, however, subject to periodic droughts and, although these do not occur frequently, they may result in a heavy reduction in crop yield. Serious droughts occurred in 1921 and 1947, a less serious one occurred in 1948 and in 1951 there was prolonged drought and crop yield was much depressed.

At Uruçuca, the mean maximum temperature ranges between 80°F. and 90°F. and the mean minimum between 62°F. and 69°F. During the winter months of June, July and August the minimum temperature may fall below 60°F. These months are normally wet and if the temperature is low the humidity will be high for considerable periods, a condition which favours pod disease.

A cocoa plantation near the Rio Jequitihonha

Topography and soils

There is a range of low hills running from north to south of the cocoa zone. In the south, the hills rise at some distance from the coast and there is a broad flat coastal plain, but to the north of Ilheus the coastal plain becomes narrow. The hills are intersected by numerous rivers, most of which are short. There are only three of any great length; they are the Rio de Contas in the north and Rio Pardo and Rio Jequitihonha.

Along the coast the soils are derived from sandstones and shales and are unsuitable for cocoa, but inland suitable soils derived from gneisses and mica-schists are to be found. Where the rock is soft and easily weathered, the soils are fertile and rich in potash.

In the south, cocoa is grown mainly on alluvial soil on the river banks. There are periodic violent floods which deposit layers of sand on the cocoa farms. In due course these layers are covered with silt again. This type of soil supports some excellent cocoa plantations, but it drains easily and therefore depends on regular flooding to supply the necessary moisture. Some of the plantations have, at times, suffered badly from drought.

Type of cocoa grown

The bulk of the cocoa is an Amelonado type, similar to that grown in West Africa, but with a slightly rounder, smoother pod. This type is known as Comum. A less common type is Para, which has a small round pod of a Calabacillo type. This is said to grow more rapidly and bears a greater number of pods than Comum, but it requires upwards of 400 Para pods to provide 1 arroba (33 lb.) of cocoa, as against 360 to 380 pods of Comum to produce the same amount. Para is also said to have a lower fat content and to be more susceptible to black pod.

There are a few isolated patches of Criollo and some Forasteros bearing bottle-neck pods known as Maranhao.

Plantation practice

In the early days of planting, much of the cocoa was established after the forest had been completely cleared, and some of it was shaded with annual food crops in the early stages. A great deal of the older cocoa on estates was planted on contract, the contractor having control of the land until the cocoa came into bearing. Of recent years the better managed estates prefer to use estate labour for planting.

Planting is commonly 'at stake,' several seeds being planted per stand. As the plants grow up, some of the seedlings may be taken for planting elsewhere and the remainder thinned out until only the best grown seedling remains. Nurseries are used by some estates, especially where they are endeavouring to select better material for planting. Where cocoa is planted on good soil with a reasonable degree of skill it will come into bearing in the fifth year, and by the seventh year will give a profitable yield.

The spacing distances are usually reckoned as so many 'palms' (the distance measured by the span of the hand, about 9 in.). Wide spacing is 20 palms (about 15 ft.), medium is 18 (13.5 ft.) and close spacing is 14 (10.5 ft.). A spacing of 13.5 ft. is commonly adopted. Yields are estimated in arrobas per 1,000 trees and a yield of 25 to 30 arrobas per 1,000 trees, which is equivalent to 350 to 400 lb. per acre, is quoted as an average yield.

As in so many other countries, the merits of shading and leaving cocoa unshaded are much discussed. Evidence from Bahia suggests that, on the whole, cocoa does better when shaded and at the time of our visit the healthy appearance of the well-shaded cocoa trees was striking. Experience during droughts has shown that cocoa under shade suffered less than where shade was absent.

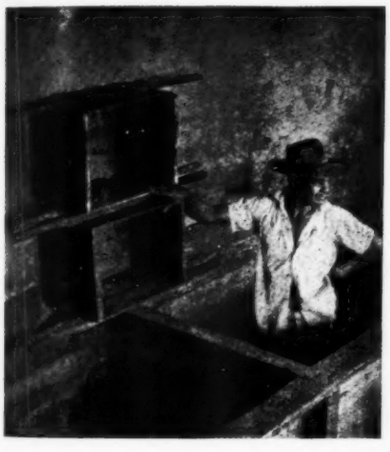
For many years after cocoa had become an important crop permanent shade was not considered necessary, but later shading was favoured by a number of progressive planters. The Bahia Cocoa Institute has advocated the use of shade for a good many years

past. At the present time, a large proportion of the cocoa is grown under permanent shade, and the trees in most general use are *Erythrina velutina* and *Inga zera*, the latter being favoured on alluvial soils.

In opening forest land for planting it is nowadays usual to thin the forest trees, leaving a sufficient number of trees to provide shade for the young cocoa. On the whole, it is considered more profitable to open forest anew for planting than to rehabilitate an area of plantation that has suffered badly from drought.

Harvesting

There are two harvests, the 'temperao' (literally means the mid-crop)



A typical fermenting box. The two small boxes with handles are 'catchets' in which the wet cocoa is measured

from May to August, and the 'safra' from September to January, so that harvesting is continued through the greater part of the year. Although the safra is usually referred to as the main crop, the temperao has of recent years been approximately equal to it or even greater.

The following figures published in the monthly report of the Bahia Cocoa Trade Commission show the relationship between the temperao and safra crops. The figures represent the number of bags of 60 kilos (17 bags = 1 long ton or 2,240 lb.) harvested.

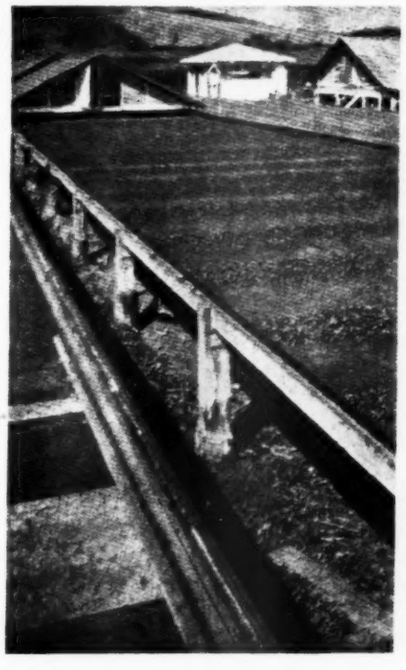
Year	*Temperao*	*Safra*
1946-47	1,200,000	1,265,100
1947-48	400,000	985,685
1948-49	350,000	1,332,028
1949-50	1,000,000	1,612,000
1950-51	700,000	1,407,000
1951-52	1,100,000	570,000

On the better managed estates, it is usual to limit the harvesting period to a week, beginning on a Monday, the pods being opened on the following Monday. After the pods are harvested, there is often delay in breaking them and bringing them to the fermentary. One of the reasons for this is the fact that harvesting is often done on contract, and it usually suits the contractor to spread the harvesting over a long period.

Smallholders may leave the beans in the pods, or in heaps for a considerable time after removing them from the pods. Transport of the wet beans is mainly by mule or by canoe. A great deal of wet cocoa is transported by canoe for processing at Belmonte. It becomes partially fermented *en route* when exposed to rain. Those responsible for processing it at Belmonte have to judge the extent to which it has already been fermented.

Fermentation

The fermenting boxes are constructed of wooden planks; a few estates still use concrete boxes lined with wood. The size of boxes varies considerably, the dimensions 10 ft. long by 4 ft. wide and 4 ft. deep being common. The provision for draining away the 'sweatings' which accumulate in the early stages of fermentation does not seem to be regarded with the same importance as in other countries. Frequently, there seems to be no provision for draining, but often there are holes for drainage, although these tend to be blocked with mucilage.



A typical *baraça* on which the beans are dried in the sun. The rows of beans are moved from time to time to a dry part of the floor and to expose them to the sun

In most countries, it is normal practice to cover the cocoa in the fermenting box with banana leaves to ensure that the fermenting mass generates the necessary heat. In Bahia, however, covering the beans is the exception rather than the rule.

The period during which the beans stay in the fermenting box varies on different estates. Some ferment for as long as six days, but three or four days' fermentation is common. The length of time during which cocoa is fermented seems short when compared with the time given for a similar type of cocoa in West Africa. The cocoa is usually turned every day from the time it is placed in the box.

Drying

As weather suitable for sun-drying usually only occurs for short periods, the bulk of the cocoa is dried artificially or by a combination of sun and artificial drying. All estates are provided with sun-drying equipment, known as *barcaças*, which consist of a simple drying floor with sliding roof. In a few cases there are additional sliding trays.

Two types of artificial driers are in general use. Both are referred to as *estufas* and use wood as fuel.

1. *Estufa de balcao.* This type of drier consists of three to six wire mesh trays placed one above the other over a hot flue. The trays are 10 to 15 ft. square and run on rails so that they can be withdrawn for loading and unloading. The temperature is controlled by adjusting air inlets at the bottom of the *estufa* and by controlling the fire.
2. *Secador.* This is a simpler type, consisting of a drying floor which is either solid or made of slats, with a hot flue underneath. The drying floor is at least 10 ft. above the flue, so that there is a large volume of hot air underneath.

An improved type of *estufa de balcao* was seen at Belmonte. It had trays at both ends which could be slid alternately into a space in the middle of the building. The temperature was controlled by regulating the outflow of air through a flue on the roof.

Most artificial driers are well designed and the smoke is led away without affecting the cocoa.

The time taken for complete sun-drying naturally varies with the amount of sunshine, but it can be dried in from four to five days in good weather. In cloudy weather, it can be left for four days and finished off with a further 18 hours in the *estufa*. If sun-drying is limited to two days, then 25 to 30 hours' drying are required in the *estufa*.

Total or partial sun-drying of the cocoa is always preferable. It is estimated that the loss of weight by drying in the *estufa* alone is 7% to 8% greater than by sun-drying. Apart from the loss in weight, it is generally considered that cocoa sun-dried, or partially sun-dried, is superior to cocoa that is dried solely by artificial means.

Inspection and grading

The following grades have been set up:

1. *Superior*. Consists of mature, well-fermented, dry cocoa free from foreign odours and with limits of 4% for beans affected by mould and insects (*i.e.* capital defects) and 1½% for unfermented beans (*i.e.* common defects).
2. *Good/Fair*. Consists of cocoa of the same description as Superior, but with limits of 7% for capital defects—3½% for mould and 3½% for wormy beans—and 3% for common defects.
3. *Regular*. Consists of fermented, dry, clean beans, devoid of foreign odours with limits of 10% capital defects and 5% common defects.
4. *Inferior*. Consists of dry, fermented cocoa with up to 15% capital defects, 7% common defects and 3% impurities.

In practice, only the first two grades are used and over 90% of the cocoa exported is Superior grade. There are no statutory price differentials for the various grades, but the exporters offer a differential of one cruzeiro per 15 kilos for Superior grade. (The price of cocoa in the zone was about 400 cruzeiros per 15 kilos in May 1954.) There is no official inspection of cocoa up-country, but a Government body, the Bolsa de Mercadorias, has the task of inspecting shipments of cocoa.

Smallholdings and estates

It is estimated that some 80% of the cocoa is grown on smallholdings and the remainder on estates. The smallholdings in Bahia, however, are much larger than those in West Africa. The better estates under the supervision of capable personnel are well run. On the other hand, a large proportion of the estates are owned by absentee landlords and the supervision is often indifferent.

Labour

Smallholders and their families usually have their own plantations and employ casual labour from time to time. Estates employ permanent labour, which is normally housed on the estate. In addition, a large proportion of casual labour is employed during the busy periods in cleaning the farms and harvesting.

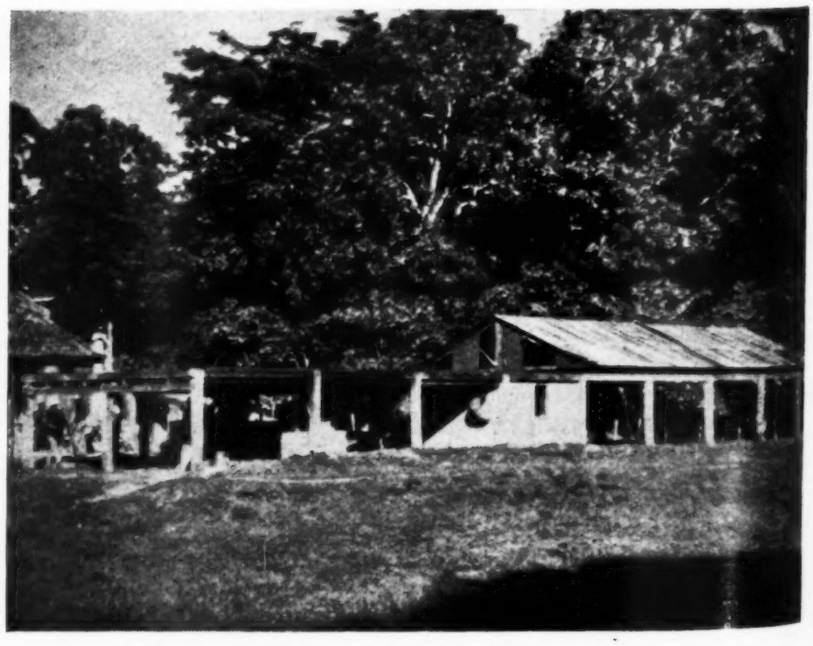
The bulk of the casual labour comes from the states of Pernambuco and Sergipe, north of Bahia. The rapidly developing manufacturing industries of Sao Paulo in the south attract a large proportion of the labourers who would otherwise find a living working on cocoa in Bahia.

Diseases and pests

The most important disease is *podridao parda* or brown pod caused by *Phytophthora palmivora*. It has been known in Bahia for many years. It is estimated that it now causes a loss of 18% to 25% of the total production of the cocoa zone, equivalent to 20,000 to 30,000 tons. There is considerable variation in the incidence of the disease from farm to farm and from district to district, losses being as high as 40% to 50% in some farms. Brown pod normally makes its appearance in June, when the nights are cool and humid. If conditions continue favourable for the spread of the disease, it will cause severe losses of the pods maturing in the second half of the *temperao* crop and of young pods which would form the *safra* crop.

The disease has been studied at the research station at Uruçuca, where spraying with the proprietary chemical 'Cuprosan' was found to be effective in reducing its incidence to a low level. The Bahia Cocoa Institute and other organisations launched a campaign in August 1953 to demonstrate the means whereby brown pod could be kept in check.

The institute recommends sanitary



A *baraça* with cocoa trees in the background. The latter trees are *Erythrina velutina*

measures, including keeping the plantation clean and the frequent removal of infected pods. It is also recommended that the trees should be sprayed with 'Cuprosan' in February and March, with a further spraying in May and July. Two types of spraying machines are in use, a knapsack sprayer of German design and a sprayer designed for carrying on mule - back, developed locally. The technique adopted in Bahia is to spray the whole tree to destroy infection. This system differs from that in Nigeria, where the pods only are sprayed.

Some plantation managers insist that complete control of brown pod can be maintained by sanitary measures, such as frequent removal of infected pods. We visited one plantation where rigid sanitary measures were applied and found a complete absence of brown pods.

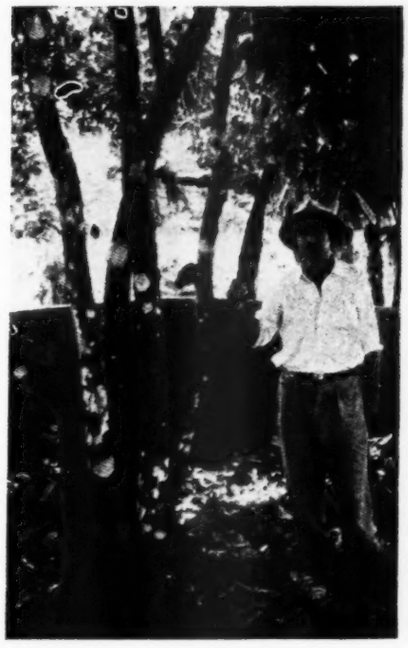
Spraying is still in its experimental stage. It may well prove, as in Fernando Po, to be effective and economic if skilfully applied, and at least as effective as the sanitary measures recommended. On the other hand, the removal of affected pods, combined with spraying, may be the most economical system of saving the crop from this devastating disease.

The more troublesome pests are: Enxerto ants (*Azteca paraensis*), parasol ants (*Atta cephalotes*), thrips and capsids (*Monalonion* sp.).

The Enxerto ants were a major pest some years ago, but recently they seem to have been kept well under control, at least on estates. They live in epiphytes and collect leaves and small branches from the trees to build their nests. They harbour mealybugs which suck the sap from the trees, and this combination of ants and mealybugs does a great deal of damage.

Parasol ants can also do a good deal of damage by removing large quantities of leaves from the cocoa trees to build their nests. They can, however, be controlled by the use of chemicals. Thrips and capsids do a certain amount of damage, but are not of major economic importance.

Rats have on occasions wrought great damage, especially after severe drought, when their normal food supplies are scarce. They have been controlled by the destruction of their nests, which are usually in trees. Monkeys do much harm from time to time and birds, including parrots, are destructive.



This was one of the first cocoa trees to be planted in the State of Bahia. The original tree was planted 200 years ago. The stems seen in the photograph are chupons arising from the original stock

Research station at Uruçuca

This research station was founded in 1931; the main lines of research have been selection, the study of pests and diseases, and manuring. Many trees were selected for propagation. The yields of these vary from 3 to 8 kg. per tree. The intention is to distribute these selections as seed, but as yet no high-yielding seed is available.

A white mutation of the Comum type was found on a local estate. This tree has been propagated by seed and there are several acres planted at Uruçuca which are now in bearing. It was first described by Drs. Miranda and Silva in 1939. The progeny appear to breed true and it is claimed that the butterfat content is as high as 70%.

The study of brown pod disease has received particular attention.

The staff consists of the director (who is also an agronomist), a plant pathologist, a geneticist and a meteorologist.

The Bahia Cocoa Institute

This institute was founded in 1931 at a time of crisis in the cocoa industry. Previously farmers had borrowed money at exorbitant rates of interest and when prices slumped many fell heavily into debt. The main task of the institute was to provide credit at reasonable rates of interest. The other objects were the improvement of communications, the provision of good storage facilities and the initiation of research.

The institute, of which Dr. Tosta was the first president, did much good work during the thirties, including the building of roads and bridges. In 1944, it was given a monopoly of the buying and selling of cocoa. This monopoly lasted until 1946, when normal exporting business was resumed. Since then its buying activities have declined and are now on a relatively small scale. It is now mainly concerned with administering the research station at Uruçuca.

The Bahia Cocoa Trade Commission

The commission, with Dr. Tosta as president, was first instituted in 1949 and is composed of the cocoa-exporting firms. Its purpose is to discuss and disseminate information on world markets and fix minimum prices at which exports will be made. The commission compiles statistics of production and consumption throughout the world and publishes reports giving information which may affect local production and market prices.

Cocoa butter factories

The first cocoa butter factory was built in Ilheus in 1928. Others were built before and during the last war, largely because of the increased demand for cake for theobromine extraction. There are now six factories in Ilheus and Salvador whose intake of beans rose to nearly 30,000 tons in 1950-51 and 1951-52. This is 20% to 25% of the whole crop. The annual exports of cocoa products amount to 8,000 tons of butter, 2,000 tons of mass and 10,000 tons of cake, of which half is edible. Recently, the high prices and the new exchange policy have placed the cocoa butter industry in a difficult position.

Pigeon Towers and Pigeon Guano in Iran

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In this article the author gives an account of the pigeon towers which have attained considerable popularity in Iran and neighbouring countries as a means of making available supplies of guano for manuring crops in conditions where supplies of manure and fertilisers are difficult to obtain.

STRUCTURES like the ones seen in the attached photographs are commonly seen around the ancient city of Isfahan in central Iran. They have been observed at least 100 kilometres in all directions from Isfahan, but they probably occur at much greater distances. No statistics exist about their numbers, but there are probably a few thousands. In certain villages close to Isfahan there are large numbers; in one village, for example, as many as 24 have been counted.

History

The exact history of pigeon towers is not known, but there are 500-year-old records of their sale in existence. Except for the few towers built in the last 20 years most of them were built earlier than the memory of any living person.

The management of run-off water from the tower roof tops is an important part of their maintenance. Repairs are also often needed to the outside walls, but the frequency of repairs to the interiors appears to be only once in many decades. No major repair has in fact been done to many of the towers in the last 50 years, and, as a result, one often finds a pigeon tower in ruins with only part of its characteristic honeycombed walls still standing. Because of lack of maintenance and the small amount of new construction, there are probably fewer towers in Iran than 100 years ago.

Object of the towers

The collection of pigeon guano is the only object of the towers. Its use is mainly as a fertiliser, but a small amount is also used for tanning. It is of great importance in the economic life of the local farmers, and because of this importance, the pigeons themselves are more or less sacred.

The height of the towers normally varies from 10 to 20 metres and the diameter from 5 to 10 metres. They are built to provide the maximum number of pigeon holes, a large tower having as many as 50,000 holes; each hole is about 20 cm. by 25 cm. by 30 cm.

The design of these towers falls into three general patterns: (*a*) The standard type found around Isfahan which stands by itself (Figs. 1 and 2). (*b*) A second type which is built as an extension of dwellings or on house tops (Fig. 3). This type has a very much smaller capacity than the standard Isfahan type. (*c*) A third type which is long and rectangular has been observed around the village of Gulpaigan, about 180 kilometres north-west of Isfahan. A modification of the third type where the tower is rectangular but not very long, has been observed at Kabul, Afghanistan (Fig. 4). The principle in all cases, however, remains the same, *i.e.* to provide a safe dwelling for pigeons and a place where guano can accumulate.

Fig. 1. This pigeon tower near Isfahan is in working condition and is of the usual type

The depth of the foundation for these towers depends on their type and size as well as the building material available. Most of the interior and a good portion of the exterior are made with sun-dried bricks. However, some of the top inlets are made with baked bricks, at least in their outer layers, to reduce the damage from rains.

The time required to build a tower of medium size, employing 20 men to do the job, is stated to be about six months. The towers belong to individual farmers and are considered as one of their more valuable assets. As an example of their value, one of the larger towers was recently sold for 200,000 rials (present exchange rate is approximately 80 rials equal $1 and 18 rials equal one Indian rupee), while a very small pigeon tower built about three years ago cost between 30,000 and 40,000 rials. On an average, about 1,000 pigeons live in a tower, but the exact number depends on the size of the tower, the proximity of water, the nearness of green fields or other sources of food, and the absence of snakes or other animals that can get into the towers and prey on the pigeons.

Hunting near the towers is considered very bad for the yield of guano, and no hunter is allowed to shoot within several hundred metres of a tower.

Yield of guano

The yield of guano per tower depends on the number of pigeons residing in it. The yield varies from month to month depending on the food supply. Many times in winter when snow is on the ground, the pigeons are artificially fed with millet. This may amount to as much as 120 kilos per day per tower. On such days, if the pigeons are not fed artificially, not only is there a reduction in the yield of guano, but there may also be some casualties. In general, the yield per tower varies from about 600 kilos to as much as 3 metric tons per year.

The towers are usually tapped once a year. Some may be tapped twice in one year, and a small number of towers are not tapped every year. There is generally one door to a tower which is sealed when not in use.

The processing required for pigeon guano is simple. After collection, the guano is dried and kept ready for use; if it is required for broadcast application to crops, the material is broken down and flattened with spades before it is applied.

Analysis of pigeon guano

An analysis of pigeon guano shows it to have the following precentage composition:

Organic carbon	34.80
Organic nitrogen	2.71
Total nitrogen	2.88
Total phosphoric oxide (P_2O_5)	1.67
Total potassium oxide (K_2O) ..	0.77

The above analysis is due to Mr. E. Hadji, Soil Chemist of the Faculty of Agriculture at Karadj, Iran.

Rates of application of guano

Pigeon guano is applied to crops at varying rates depending on the crop itself, the previous history of the field, etc. For row crops, like cotton or opium poppies, guano is usually broadcast at the rate of 1.2 metric tons per hectare; for fruit trees such as peaches, pomegranates, apples and cherries, it is given yearly at the rate of 600 to 800 grammes per tree. It is extensively used in the cultivation of melons which usually receive more than 50% of the total supply of pigeon guano available.

Fig. 2. This pigeon tower, not in working condition, gives some idea of their size

Reliable information concerning the response of crops to applications of pigeon guano is impossible to obtain. Obviously, the crop response varies with the history of the land, the type of soil and the demands of particular crops. No experimental data based upon properly conducted trials are available to enable a judgment to be formed, but cultivators who have been in the habit of using this material for many years, assert that its use may lead to as much as a 50% increase in yield.

Discussion

The fact that these pigeon towers have been continually in use for many years in Iran and neighbouring countries seems to indicate that they must have some basic value as sources of manure and for maintaining soil fertility. Around Isfahan, for example, mixed farming is practised to only a small extent, while some of the crops grown, such as melons and cotton, are known to make heavy demands on nutrient elements in the soil. Moreover, the cattle population is very small, and the limited amount of cattle manure that is available tends to emphasise the value of pigeon manure which therefore acquires a very great importance.

Commercial supplies of artificial fertilisers are not available, or if they are it is only at a prohibitive price. This, too, is another reason for the continued popularity of pigeon guano.

The food supply of the pigeons is also of importance and has a bearing on the economics of the pigeon tower. Normally, these birds eat cereal grains such as wheat, barley or millet, although they also eat seed of grasses and of alfalfa, and some other legumes. The fact that they make a definite draft on crops has therefore to be taken into account, since the fertility

Fig. 3. Pigeon towers on house tops, near Isfahan

Fig. 4. A pigeon tower near Kabul, Afghanistan

conveyed in pigeon guano is obviously obtained at the expense of diminished yields of crops.

On the other hand, as the nutrient elements removed in crops are under existing practice practically never returned to the fields, while the food eaten by pigeons does come back to the land in a readily available form, it seems that this system of manure production may have some merits, especially if the provision of readily available artificial fertilisers at an economic price is a difficult problem. In any case, this ancient and unusual method of making available additional supplies of manure is of definite interest.

Acknowledgments

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Problems Involved in the Extension of Maize Cultivation into Northern Temperate Regions—

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been found very successful. However, if such a crop is to be grown in regions in which it will not ripen grain, it is impossible to produce hybrid seed for this purpose in the same region. There must then be annual importation of seed grain. Most European countries are limited by dollar exchange problems from making great use of available American seed. The rapidly expanding maize production of South Africa could overcome some of these problems which may be only temporary.

Other uses for maize

Maize is, of course, primarily a grain crop for consumption by stock, and secondarily a silage crop. However, there are great potentialities for its use, and in America the crop is used in at least 500 different ways. These vary from glue production to breakfast cereals, and from plastics to the use of maize as a source of furfural for the chemical synthesis of, amongst other things, specific growth regulators, such as 3.6.endoxy hexahydro-phthallate. There are clearly great benefits to be gained if maize can be still further suited to European cultivation.

Conclusion

Especially interesting problems always arise when a crop is cultivated near the limits of its physiological tolerances. Hazards which in the central zone of production may be barely perceptible assume dangerous proportions when the crop is growing less vigorously. The extension of maize into northern temperate regions therefore presents many problems, particularly to the plant breeder, the plant pathologist and the physiologist.

Colonial Spraying Pool

A pool of spraying and dusting machinery which will contain equipment suitable or potentially suitable for use in the colonial territories is being established by the Colonial Office, in co-operation with the Imperial College of Science and Technology and the machinery manufacturers, at the Imperial College of Science and Technology Field Station in Berkshire, England. Manufacturers of spraying and dusting machinery have been approached through the Agricultural Engineers' Association and are co-operating in the establishment of the pool by the loan of suitable equipment.

The college has for some years maintained a representative collection of spraying and dusting machinery for teaching and experimental purposes, and this collection will be incorporated into the pool. The pool will fulfil three purposes:

1. The instruction of students (especially students preparing to undertake work in the colonies) of agriculture, entomology, mycology, etc., in the different types of equipment, their use and maintenance.

2. The demonstration of the equipment to interested potential users in the colonies, *e.g.* agricultural officers, entomologists, mycologists, farmers and planters, under conditions in which the users will be able to try the equipment for themselves, having in mind their own particular problems in the colonies.

3. The consideration of modifications to machinery to meet special conditions of tropical use. Any simple adaptations might well be completed on the spot by the staff running the pool, but more involved work would be dealt with either by a manufacturer or at a suitable research institution.

A comprehensive reference library of spraying and dusting machinery manufacturers' literature is to be formed for the use of visitors. A committee on which the Colonial Office, the Imperial College and the Agricultural Engineers' Association are represented has been set up and is responsible for the running of the pool and for the selection of machinery offered by any manufacturers for inclusion in the pool. Mr. A. E. H. Higgins, A.R.C.S., D.I.C., Imperial College of Science and Technology, is in charge of the pool.

The Abyan Scheme in the Aden Protectorate

During and since the last war developments on some scale have been in progress in the Western Section of the Aden Protectorate, having for their object the extension of cultivation under irrigation and particularly the development of cotton growing, the type chosen being the long staple variety at present grown only in Egypt and the Sudan.

THE Aden Protectorate lies in the southern extremity of the Arabian peninsula. The coastal plain is mostly an arid unproductive area, but in the high land which lies to the north there is a fair rainfall. A part of the rain discharges into wadis, some of which drain into the Abyan delta, which lies some 40 miles to the north-east of the port of Aden itself. This run-off takes the form of periodical torrential floods carrying a heavy load of silt. The floods come down the Bana and Hassan wadis on to the Abyan plain, and in the course of centuries they have laid down a thick deposit of alluvium over an area of some 120,000 acres, constituting an equilateral triangle the sides of which are some 20 miles in length.

The floods make irrigated cultivation possible and there is evidence that irrigated farming was carried out in this area in the past on a considerable scale. Of more recent years, however, agricultural operations have been severely restricted owing to perpetual internecine feuds between the tribes inhabiting the area, combined with poor health conditions, emigration and consequent grinding poverty.

In 1938, the Government of the Aden Protectorate entered the area in an effort to bring the contending Yafa and Fadhli tribesmen together on a more peaceful basis. At that time, the blood feud between the rival sultans of the territories and their followers had resulted in almost unbelievable deterioration of this compact agricultural tract; the line of former irrigation channels could still be seen and these, with the broken and deserted village sites, testified to the decline in the agricultural activities.

With the establishment of more peaceful conditions a start was made with efforts to revive agricultural production in 1940-41. In an effort to stimulate food production under the stress of war conditions, a loan of £10,000 from the Government enabled farmers to obtain oxen, seed and so forth. The political situation, however, remained unsatisfactory, but after famine conditions made their appearance in Hadhramaut greater success was obtained, and in 1943 a second scheme, the so-called Khanfar scheme, was inaugurated with further financial assistance from the same source; during the four years of its existence it brought an area of approximately 5,000 acres under development in irrigated farming and repaid all its borrowings except for a sum more than covered by its assets in livestock, grain and fodder.

The Abyan Board

At the end of the four-year period, the local tribes asked that the land should be returned to them. This was, in fact, done, but the people failed to maintain the work already accomplished and deterioration once more set in. Accordingly, it became necessary for the Protectorate Government again to step in and reassume control. In 1947, the Abyan Board was created by an administrative order of the Governor of the Aden Protectorate,

Tilted tertiary limestone forming the west side of the Ligmat Bana gorge. The dry season flow of the Bana occupies a small part of the sand and boulder bed. The flow is from right to left in this view

for the purpose of controlling development in the region. This arrangement was accepted by the tribes concerned and, in order to define and regularise the scope and nature of the board's activities, an agreement was entered into between the Aden Government and the tribal authorities.

The object of the scheme was to construct canals which would enable a larger area to be more efficiently irrigated and bring previously unproductive land into cultivation. It was proposed to introduce a proper system of crop rotation, which would include cotton, food crops and fallow. The board would have power to prescribe the crops to be sown each year and to evict unsatisfactory farmers. These proposals were optimistic and have not yet become fully effective.

The board itself was modelled on the lines successfully followed in the Gezira scheme in the Sudan; its members were six in number and included representatives of the Government and of the tribal authorities.

The partners to the scheme were the board, the states and the tenants and the landlords; the functions of each of the partners were as follows:

The board erects and maintains capital works, prepares uncultivated land for irrigation, distributes the water, prescribes the area to be planted in different crops, provides facilities for collecting crop produce, makes advances in seed and cash to tenants, gins and markets the cotton crop and distributes the proceeds of sale. The tenants maintain irrigation banks and field channels, grow the crops prescribed by the board and work according to the board's directions. The landlord is responsible for the cultivation of his own land either directly or through tenants. The states provide security forces and medical, legal, social and educational services.

The returns from the scheme are divided as follows: the board, 25%; the tenants, 50%; the states and landlords, 25%.

Water supplies

As previously stated, the flood water supplies on which the scheme depends come from the Wadis Bana and Hassan. The Bana is much the more important of the two, for, in addition to major floods, it provides a perennial flow of limited volume.

Two hundred yoke of oxen with scraper boards forming a diversion bank (Oqma) across the sandy bed of the Bana. Traditional skill, efficiency, economy of effort and ingenious use of available material are displayed in this work which demands a high degree of co-operation

The total discharge may average about 145 million cu. metres. The floods are subject to great variation. Beginning in March and April, they occur intermittently and unpredictably, but are likely to be heavier, more violent and more frequent during July and August. Thereafter the volume of water is much smaller, but the Wadi Bana is likely to have a fairly steady flow of 30 to 40 cusecs for the next three months. At this time the greater part of the wide sandy bed is uncovered and serves as a track for cars and lorries.

Traditional methods of irrigation in the region are simple flooding on lines similar to those practised under like conditions in other parts of the world. When the flood arrives, part is diverted on to the fields which have been surrounded by a series of bunds. When one field has been filled a bank is broken and the water moved on to the next field. The duty of water by this method is estimated at 1 metre depth. With the recruitment of an irrigation engineer for the scheme a contour survey of the delta area was produced. Thereafter a regulator was built at the head works on the Bana and a series of distributory canals with drops and gates was constructed. The work was speeded up by the purchase of earth-moving equipment, although even today local teams of oxen working by traditional methods are also employed.

The agricultural policy of the scheme

In its initial conception, the Abyan scheme was essentially one for the production of food and, although the introduction of the cultivation of Egyptian cotton has revolutionised the economics of the project, the fundamental necessity of ensuring an ample and safe supply of food for man and beast is still one of the most important considerations. Trials with long-staple Egyptian cotton in the area were, it appears, first conducted by the Director of Agriculture in 1946, using the variety X.1730A, which derives from Sudan Sakel. Only 3 to 4 acres were planted and the results were disappointing. In the year 1948, further trials were undertaken and a total area of 82 acres was sown. The results were much more encouraging and an average yield of 1,750 lb. of seed cotton per acre was obtained. The cotton was ginned on a roller gin and was purchased by the Raw Cotton Commission at a flat rate of 31d. per lb.

The traditional grain crop in the Abyan area is dhurra, the great millet (*Sorghum vulgare*), of which a number of varieties exist. Under local tradition

After a single watering, these widely spaced plants of Egyptian-type cotton free from pests and disease will bring to maturity more than 100 bolls per tree

it is sown after the March flood, when a moderate yield of grain normally results. Other crops grown are a red type of sorghum, which in the southern part of the area is sown between September and October, and an early bulrush millet (*Pennisetum typhoideum*). The Agricultural Department has carried out numerous field trials with other crops with a view to devising a suitable rotation. Among crops experimentally tried have been legumes, notably lubia (*Dolichos lablab*) and pigeon peas (*Cajanus indicus*). It is considered that a valuable rotation might be lubia and pigeon peas with cotton and sorghum as the other members.

Subsequent developments

In 1950, a visit was paid to the scheme by Sir Herbert Stewart, at that time Agricultural Adviser to the Middle East Office; in his report he discussed certain technical aspects of the scheme and made suggestions for future work. In 1951, the Secretary of State for the Colonies appointed a mission to examine the working of the scheme and, in consultation with the Aden Government, to make recommendations for modifications that might be necessary in the existing organisation, and for the further development of the irrigated areas, as well as for the establishment of any research that might be necessary. The mission comprised Mr. (now Sir) Geoffrey Clay, C.M.G., O.B.E., Agricultural Adviser to the Colonial Office, Mr. J. W. Cummins, formerly Deputy Financial Secretary to the Sudan, Dr. Herbert Greene, Adviser on Tropical Soils to the Colonial Office, and Mr. G. Lacey, C.I.E., Adviser on Irrigation to the Colonial Office. The mission examined the working of the scheme in great detail and made a number of recommendations and criticisms on the operations and the directions which future developments should take.

They also formulated proposals for the strengthening of the administrative and agricultural staffs which the magnitude of the development made necessary, and also for the appointment of a small research team comprising an irrigation engineer, a soil chemist, an entomologist with a knowledge of plant pathology and an agronomist plant breeder.

One problem that demands investigation is a rise in the level of ground water. In some parts of the Abyan delta this has been accompanied by appearance of salts at the soil surface in amounts that plants cannot tolerate. Ways of overcoming this difficulty are being sought. One possible remedy is pumping from tube wells.

The Clay mission called attention to the possibility of developing underground supplies of water by means of tube wells, which could be used to supplement supplies available from surface flooding.

The financial history of the scheme

The scheme has been financed by a series of advances, loans and grants from Aden colony funds and from colonial development and welfare funds. So far the scheme has been financially very successful and all the funds advanced have been repaid when they fell due and a surplus achieved.

As already stated, the scheme was initiated by means of advance of £10,000 in 1940 to encourage food production in the Abyan area. This was followed by a further advance of £20,000 to enable the Khanfar development scheme to be undertaken.

The Abyan Board took over the Khanfar scheme in 1947 with its financial assets amounting to £7,932; their position was strengthened by a revolving credit of £5,600 from Aden funds and an interest-free loan from colonial development and welfare funds. In the following year a further loan from the same funds was sanctioned of £250,375; in both cases the loans were free of interest until July 1952. In 1950, it became evident that further provision of funds was necessary and further advances totalling £104,200 were sanctioned, while assistance with seasonal finance was received from the Raw Cotton Commission, which made an advance to the Abyan Board on the security of the cotton crop.

The balance sheet of the board as at September 1953 showed that the total assets of the board amounted to £1,463,710, of which approximately £750,000 was in cash or investments at short call, and the remainder in plant and equipment and fixed assets. The liabilities included £40,000 in a sinking fund towards the repayment of the initial loans, £400,000 in a general development reserve and £200,000 in a revenue stabilisation fund.

The development of the cotton industry

The success of the early experiments, combined with the high prices ruling at the time for long-staple

cotton of the Egyptian type, decided the board to step up cotton production as rapidly as possible, in order to provide funds for development. The success obtained is shown in the following table, which gives the cotton production and the area cultivated from 1949 to 1954:

ABYAN COTTON PRODUCTION

Year	*Acres planted*	*Total yield, bales of 400 lb.*	*lb.*
1949-50	1,097	1,567	634,000
1950-51	7,000	9,954	3,991,000
1951-52	9,830	7,200	2,882,400
1952-53	11,300	11,066	4,426,000
1953-54	20,000	—	—
1954-55	20,000	—	—

The first roller gin was introduced into the country in 1949. In 1951, an up-to-date ginnery with 32 gins and modern equipment for handling the crop was constructed at El Kod, near Aden. This ginnery produced 11,066 bales of lint in the season of 1952-53.

The cotton crop is sown as soon as possible after the August floods. The rows are spaced about 3 ft. to 4 ft. apart; the seed rate for planting is 12 to 13 lb. per acre. Thinning and clearing starts from 15 to 20 days after sowing; the final spacing depends on the fertility of the soil and varies from 1 ft. to 3 ft. The first pickings are obtained in January and February and picking continues until the end of May, when the plants are uprooted and burnt.

To assist cultivation, a small fleet of Ferguson tractors was introduced in 1953, which are hired out to farmers mainly for deep ploughing, but most of the ploughing is done by the traditional bullock ploughs, although a number of farmers are stated to have purchased their own tractors and equipment for ploughing.

The services of a specialist plant breeder became available in 1951, and as the result of his efforts it has become possible to build up a pure seed supply, an area outside Abyan having been set aside as a seed propagation farm, the seed from which provides planting material for the succeeding season's crop.

The Pink bollworm (*Platyedra gossypiella*) has not yet been recorded, but the following have been identified: Sudan bollworm (*Diparopsis perditor*), which destroyed some buds and bolls in February 1954; American bollworm (*Heliothis armiger*) made sporadic attacks in September 1953; leaf spot (*Cercospora gossypium*), cotton wilt (*Rhizoctonia*) and (*Pythium spp.*) occurred sporadically in some areas and has since become more frequent; while an unidentified fungoid disease has been recorded known as leaf rim blight, which attacks the edges of leaves and gives the appearance of severe scalding.

Other developments

As the results of the facilities established there, Abyan has become the main experimental centre both for agriculture and engineering in the Aden Protectorate. While the main interest at present centres in flash irrigation, possibilities also exist for the use of underground water from wells and springs. In addition to wells for domestic water supply, a number of wells also exist where water is raised for irrigation by animal lift and also by pump; these are used to irrigate small pieces of land where vegetables are grown during the winter season and melons and spices during the summer. In order to investigate the possibilities a tube well programme has been initiated.

The headquarters of the Abyan Board are located at Giar, which was formerly a hamlet near to a local shrine with a few brushwood huts and a small community of charcoal burners. Ten years later it has become a small township of 5,000 inhabitants with a school and hospital and with streets lit by electricity and shaded by trees. The board actually employs a salaried staff of 148 people of many nationalities.

Outside the Abyan area the board has acted as banker to a number of small cotton-growing schemes, while the services of the board's specialist staff have been available to assist them.

Future policy of the board

The present policy of the board is:

(*a*) To utilise all surface flow and suitable underground supplies of water to develop and extend irrigation in the Abyan district.

(*b*) To develop the production of food and cash crops and to assist in their marketing.

(*c*) To increase the wealth and prosperity of the people of the Aden Protectorate.

In order that essential supplies of grain fodder and oilseeds shall be maintained, it is not the present intention to extend greatly the present cultivated area of 20,000 acres, although an increase in the area irrigated from wells is envisaged with an increase in the production of vegetables and fruit.

The history and the present position of the undertaking constitute a tribute to the foresight of those who originally envisaged the scheme and carried it through to its present satisfactory stage of development, notwithstanding the many problems which had to be overcome.

Acknowledgments

Acknowledgment is made of an article by Mr. K. McKerron, of the Aden Department of Agriculture, which appeared in *Tropical Agriculture* and was reprinted in the *Empire Cotton Growing Review*, from which much of the detail in this paper has been abstracted, and also of the report on the Abyan scheme prepared by the Colonial Office mission which visited the undertaking in 1951, which has been freely consulted.

In addition, the manuscript has been read by Dr. Herbert Greene, Adviser on Tropical Soils to the Colonial Office, who has made a number of minor corrections and additions. His assistance is gratefully acknowledged, as is also his help in the provision of the photographs illustrating the article.

Technical News

The March issue of *Paint Manufacture* includes a preview of the O.C.C.A. Exhibition; 'The Use of pH in the Paint and Colour Industries,' by M. Déribére; and 'Thixotropy and Paints,' by R. Quaredon.

Food Manufacture for March contains 'Swedish Food Preservation—1,' by C. H. Sporle; 'Pineapple Juice,' by P. E. Seale; 'Dehydration of Potatoes,' by E. G. B. Gooding; and 'Progress in 1954'—'Baking,' by Dr. Axford, and 'Vitamins,' by F. A. Robinson.

The contents of the March issue of *Dairy Engineering* include 'Dairy Plant Safety Problems,' by W. H. Scales; 'Milk Vitaminisation by Ultra Violet is Cheap and Simple'; 'Agitation Banishes "Cooked Flavour" in Novel Milk Steriliser'; and 'Northern Dairies' Southern Outpost.'

Artificial Drying in Remote Territories and the Fuel Problem

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THE demand for increased supplies of high-quality produce now being made upon remote agricultural territories requires an improved standard of technology in all branches of agricultural engineering. This is particularly true of the drying of crops after harvesting either as an essential stage of a curing process or as a means of preservation. Engineers responsible for the introduction of such processes have not only to consider the technical suitability of various fuels, but also broader economic and ecological problems.

This article discusses some of the problems likely to arise in connection with the drying of agricultural produce for market in underdeveloped areas.

Crops concerned

A number of crops are, in some areas, artificially dried. Excluding products such as sisal,[1] tea,[2] citrus waste[3] and cottonseed, in which drying is part of a manufacturing process, examples are as follows: Rice,[4, 5] maize,[6] sorghum,[7] coffee,[8] groundnuts,[9] cassava,[10, 11, 12, 13] sago,[11] native tea,[2] cocoa,[14, 15, 60, 67] papain,[16, 17] pyrethrum,[18, 19] cardamom,[20] derris,[11, 21] cinchona,[1] pepper,[22, 23] chicory,[24, 25] palm kernel,[26] banana,[27] wattle bark,[28] chillies,[26] tobacco,[29] copra.[11, 30, 31, 32, 33]

Many other crops are dried in the sun or in shade and may eventually profit by artificial drying. Examples are: Allspice, cloves, cinnamon, sarsaparilla, nutmegs, arrowroot, cocoa, soft fruits,[34, 35, 36] cochineal, mace, kola-nuts, indigo, sweet potato,[37] saffron, kapok, ginger, turmeric, ipecacuanha.

The wide range of drying conditions encountered is illustrated by the table of moisture contents before and after drying and the air temperatures commonly used (Table 1).

Local methods

Two general native methods of drying are distinguishable. In the first, the crop to be dried, frequently cereals, is stored on rafters or in baskets so that it can be reached by the smoke of cooking fires.[38] In the second, mud ovens are constructed in which the crop (copra, acrea-nut, etc.) is suspended.[11]

Existing estate methods are naturally more elaborate and are of three main types:

1. Large smoke kilns in which the products of combustion from a wood or husk fire are evenly distributed beneath a horizontal grill upon which the crop is placed.[24, 39]

2. Hot table kilns comprising a large brick flue with a flat concrete or iron top to carry the crop and having a fire box at one end and a chimney at the other.[11]

3. Flue kilns in which a large drying chamber fitted with stacks of perforated trays or other suitable carriers, such as poles, is heated by brick or metal flues. The products of combustion do not come into contact with the crop, while the circulation of air can be encouraged by tall chimneys.[30, 40]

The disadvantages of these methods are obvious: contamination of the product by smoke is liable to occur in direct heating systems (when vegetable fuel is used), while thermal lag and inefficient heat transfer are difficult to avoid in flue systems. Although these types of equipment can often be constructed by estate labour using local materials, it does not follow that they are cheap either in first cost or in fuel and maintenance.

Published data on the performance of such estate units is meagre, but their thermal efficiency is low. For example, pyrethrum flue kilns are reported,[18] to consume about 1½ lb. wood per lb. of dried flowers when operating efficiently, and up to 4 to 6 lb./lb. under less favourable conditions. Taking an average of 3 lb./lb., the specific fuel consumption is about 7,500 B.Th.U./lb. water evaporated. In an experimental tunnel drier, this has been reduced to about 5,000 B.Th.U./lb. water evaporated, using charcoal fuel. With wood-fired tobacco barns a fuel consumption of 2 lb. of wood/lb. finished tobacco is regarded as efficient, while the Rhodesian average is reported as 7 lb./lb.[41]

European methods

If artificial drying is to be encouraged, the performance of existing local methods must be improved, *e.g.* by the use of well-designed furnaces,[49] but the introduction of European methods must also be considered.[69] In the latter case, such methods are almost certain to involve the use of forced draught fans to obtain a controlled air flow through the wet material, and

TABLE 1

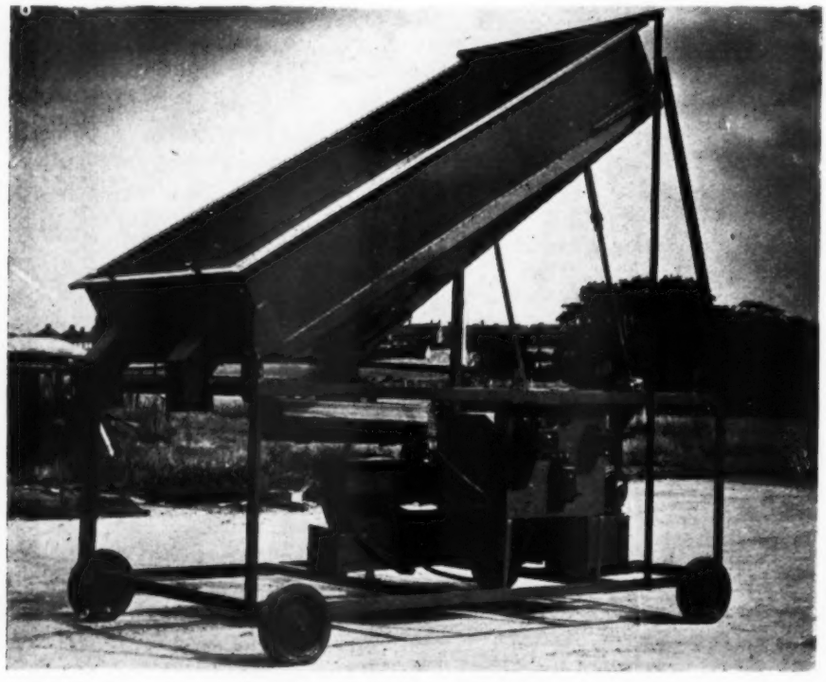
Crop	*M.C., % (wet basis) before drying*	*M.C., % (wet basis) after drying*	*Typical air temperature, °F.*
Cassava (flour) ..	Press dried to 40-45	10-11	140-170
Cassava (tapioca) ..	After cooking 44	10	120
Cereals	20-30	12-14	70-200
Copra	Wilt to 45	6	
Cardamom	75	12	100
Bananas	80-85	15-30	120-125
Groundnuts	25-40	7-9	115
Pyrethrum	70-75	8	140
Papain	85	8	100
Derris	51	10	130
Coffee	50-55	12	120

TABLE 2

Type	*Material*	*Material m.c. range, % (wet basis)*	*Air temperature, °F.*	*Typical specific fuel consumption, lb. H_2O/gal. fuel oil*	*Ratio, Fuel energy / Mech. energy*
1. Ventilated silo	Cereals	21-14	70-80	81	3
2. Ventilated barn	Wilted green crop	45-15	70-80	123	8
3. Platform for sacks	Cereals and pulses	21-14	100	50	17
4. Tray	Cereals and pulses	21-14	100-110	45	18
5. Kiln	Fresh green crops	78-12	140	57	53
6. Continuous flow tower with elevators	Cereals	21-14	150	50	19
7. Tray without circulation	Fresh green crops	78-8	220	55	78
8. Continuous flow with recirculation	Fresh green crops	78-8	300	100	54

TABLE 3

Type	*Capacity*	*Oil fuel consumption, gal./hr.*	*Mechanical power, h.p.*	*Hot air temperature, °F.*	*Evaporative capacity, lb. H_2O/hr.*
Platform for 40 sacks	2 tons cereal	1-1½	4	90-100	50
Tray, 10 ft. by 6 ft. by 18 in.	1¼ tons cereal	¾	2½	100-110	50
Forced draught kiln, 20 ft. by 20 ft.	1 ton wet green crop	4	5	140	230
Tray, 16 ft. by 7 ft. by 2 ft. 6 in. no recirculation	¾ ton wet green crop	7½	6	220	410



A 1¼-bu oil-fired tipping tray drier for cereals. The fan outlet allows an integral pneumatic conveyor to be fitted

mechanical as well as thermal energy is therefore required. The mechanical power needed is likely to be between 3 and 15 h.p., while the ratio of thermal to mechanical energy required varies widely, depending upon the type of machine and the type of material to be dried. Table 2 gives particulars for eight typical European driers.

The first two of the above are slow drying rate processes suitable for drying crops in storage and are notable for the relatively small ratio of thermal mechanical energy. In some cases, it is possible to dispense with an air-heating furnace and to derive sufficient waste heat from the coolant and exhaust gases of the prime mover driving the ventilating fan, since the thermal efficiency of some I.C. engines is of the required order. In general, however, it is necessary to consider systems requiring independent thermal and mechanical energy sources. Of these, Nos. 3, 4, 5 and 7 are possibly of most interest; particular examples of this type are given in Table 3.

Fuel for furnaces

Oil fuel

In areas where the use of motor transport is widespread there would be a tendency to use oil-fired air-heating furnaces. It would also be natural to employ, wherever possible, direct heating, particularly with high moisture content crops of low cash value. However, especially with high value food crops, it may be desirable to consider using indirect heating via a heat exchanger. When artificial drying is introduced with little or no previous experience of the significance of contamination which may occur from direct firing, buyers faced with an important modification in crop treatment may of necessity adopt a cautious attitude. Considerable experience may be required to establish the status of contamination and it is possible that the best solution would be the introduction of a heat exchanger. In addition, fire risk is reduced, as sparks from the furnace cannot reach dry material which may have accumulated in the base of the drier. The simplification thus obtained may offset the various engineering problems, such as the avoidance of staining from contact with metal surfaces.

Crops for which it may be desirable to consider the use of a heat exchanger

are coffee, papain, pyrethrum, chicory, tobacco, copra, groundnuts and cocoa.

Local fuel

If oil fuel is not available, a local fuel may be suitable which might well be a crop waste product of which the disposal by burning might be an advantage.

The number of crops which give rise to usable waste products is uncertain and the situation is complicated by variations in climate and harvesting methods. In addition, it is necessary to ensure that residues are not burnt when the overall economy would be strengthened by using them for other purposes, such as feed, manure or mulch. On a factory scale the problem is simpler, since agricultural economy is of less importance than technical efficiency. The following are some of the crops which have potentially useful residues: Sisal, sugar cane, coconut, cotton, cocoa, coffee, groundnuts, rice, citrus fruit pulp, maize, wattle (wood), cinchona (wood), hard-shelled nuts and essential oil plant pulp.[42]

Generally, however, wood is the natural choice of vegetable fuel for air heating in areas where petroleum cannot be obtained economically. The problem of burning wood without contaminating the crop to be dried has led to the use of indirect heating, as in the case of the flue kilns already mentioned, and of attempts to use charcoal. The latter, if adopted on a large scale, might lead to the operator having to make his own charcoal[43, 44] if the supply from local sources was inadequate and of unreliable quality. It must, however, be borne in mind that the production of charcoal is a wasteful process[45, 46]; the yield is only about 25% by weight of the original wood, with the calorific value rising from, say, 7,000 to 13,000 B.Th.U./lb. About 55% of the initial energy is therefore wasted and as this is of the same order as the heat lost in a simple wood-fired flue system it is unlikely that charcoal will come into general use.

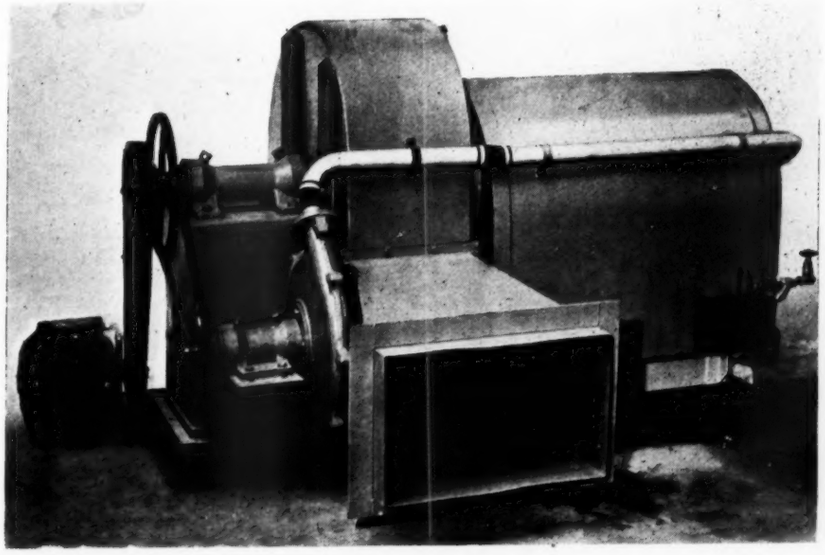
The agricultural problems raised by wood burning are illustrated by official recommendations in Kenya that for pyrethrum drying timber should be planted at the rate of 1 acre per 10 acres of crop.[1] Assuming a yield of ½ ton of dried flowers per acre and the use of 6 lb. wood/lb. of dried flowers, if the trees take 10 years[47] to reach fellable dimensions 1 acre of plantation would be required per acre of flowers.

Similarly, in Rhodesia, it has been recognised[41, 48] that about .96 acre of plantation timber is required to flue cure 1 acre of tobacco, while 16 acres of indigenous woodland per acre of tobacco would be required if non-destructive selective felling is practised. The difficulties of non-destructive felling in practice are considerable, requiring continuous supervision of labour to avoid over-cutting and erosion as the result of exposing ground that cannot immediately be absorbed into the cultivated acreage.

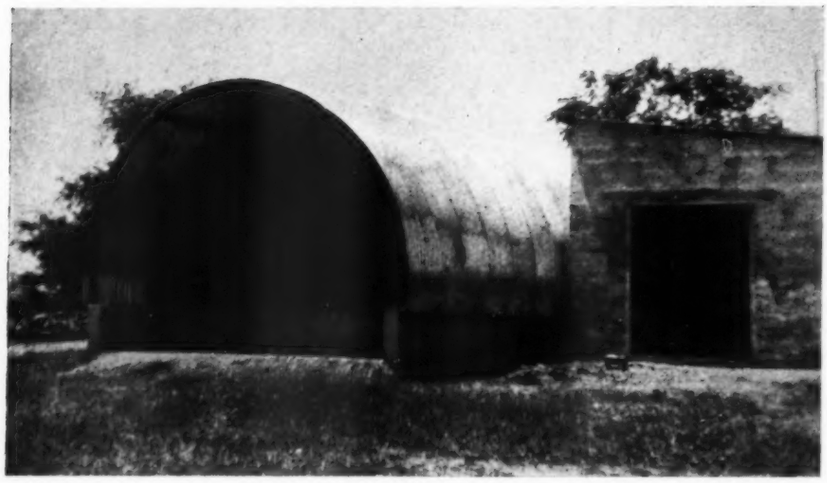
A typical drying platform for 48 1-cwt. sacks

Fuel for prime movers

Except in special cases where electricity can be used, the internal combustion engine is the obvious first choice of prime mover. Although it uses imported expensive fuel, it has the advantage of low first cost, simplicity of operation, lightness and independence of water supplies and it can be replaced with little difficulty,



A typical oil-fired fan and heater unit for platform or tray driers, suitable for either electrical or I.C. engine drive



An oil-fired I.C. engine-driven platform drier for sorghum in the Sudan. The four-engine unit is arranged in the separate house next to nissen type hut. Dried grain awaiting despatch is stacked alongside the sack apertures

especially with small units below 10 b.h.p. The quantity of fuel required is small and the introduction of such a unit in territories where motor transport is conventional should not cause difficulties. In mechanised farming areas it is possible that a tractor could be used.

In very remote areas or where petroleum cannot be obtained power for prime movers can be provided, in principle, by producer gas, alcohol or methane from vegetable sources.

The production of alcohol has not so far achieved practical success on a small scale.[50, 51, 61] Producer gas can be made from wood, but, unfortunately, the equipment is costly and heavy, while substantial water supplies are likely to be required for scrubbers, and the operation of the plant requires skilled attention.

Some of the objections are removed by using charcoal as fuel.[52, 53] Small units similar to those produced in Europe during the war could be employed, although engine contamination and corrosion would be more severe than with petroleum fuel, while lubricating oil would still have to be imported.

Two 20-ton grain silos in the Sudan made of local brick with steel reinforcement and rendered with cement

The production of methane by the bacterial decomposition of cellulose has now reached the development stage as the result of French and German research.[54, 55, 62] Two plants are in use in the United Kingdom, just over 1,000 in France and North Africa,[56] two in Madagascar,[57] 10 in Germany[58] and 200 to 300 in Italy,[68] while experimental work is being undertaken in India,[63] East[64] and West Africa.[65]

Straw, vegetable wastes and manure are potential sources of gas which can be burnt in normal four-stroke engines. The basic requirements for the successful production of gas appear to be as follows:

1. Inoculation with methane-producing bacteria[66] if these are not prevalent.
2. Exclusion of air to prevent aerobic fermentation.
3. Maintenance of an operating temperature of 86° to 90°F. to obtain an economic output rate.
4. Maintenance of a slight alkalinity (pH 7.5) to inhibit development of parasitic reactions.
5. Prefermentation of material in air to allow oxidation of sugars, etc.

About 50% of the dry matter can probably be gasified economically, while the average rate of gasification is dependent on the temperature. In European practice, total yields of about 2,000 cu. ft. of gas per ton of manure and 6,000 cu. ft./ton of straw have been obtained. The duration of the cycle can vary from two to six months. The gas is likely to have a methane concentration of around 60% and a calorific value of about 700 B.Th.U./cu. ft. One of the practical difficulties is the maintenance of an adequate working temperature during winter. The gas cannot be compressed and stored in bottles economically on a small scale and seasonal demands for fuel may cause difficulties.

Nevertheless, the method merits serious consideration, especially as the gas can be used for many domestic purposes, while the exhausted material is a potential manure.

If neither petroleum nor vegetable gas are suitable the final possibility is the use of steam. Unfortunately, the development and manufacture of small steam engines has been for many years

restricted by the widespread use of electric or internal combustion prime movers. It is significant that the recent development[59] of a 2½-b.h.p. unit for overseas use capable of burning vegetable fuel should have been initiated by an official body, the N.R.D.C., rather than by normal commercial agencies. Such units, possibly of, say, 5 b.h.p., would be suitable for several types of artificial driers and could be expected to have overall thermal efficiencies of about 5%; that is, 7 lb. of wood (7,000 B.Th.U./lb.) per b.h.p. hour. A 5-b.h.p. engine running eight hours a day for six days a week would require about ¾ ton of wood per week.

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Western Europe's Grain Harvest

ERIC FORD

FROM figures recently released by the Economic Commission for Europe (ECE) it is possible to derive a reasonably clear picture of the 1954 grain harvest, which, although falling below the exceptional level of 1953, was not so disastrous as was feared at one time. In fact, as the accompanying table shows, the 1954 harvest was above the average of the years 1948-52, with the exception of Yugoslavia.

Comparing the 1954 bread grain harvest with that of 1953, it will be seen that the moderate over-all decline is the result of bumper crops in a few countries and sharp declines in others.

Crops in France, Spain and Portugal

Bumper crops of wheat, for example, have been produced this year in France, Spain and Portugal. This has been particularly marked in the case of Spain, which has had its best harvest since 1934. This would seem to indicate that Spain may be able to meet its own requirements of bread grains, a rare event in a country which for many years has depended on heavy food imports. The fact that Spain can cover its internal needs in a good year may encourage its farmers to undertake much-needed improvements, thus enabling the country to become permanently self-sufficient in wheat.

So far as France is concerned, this year's harvest is 1 million tons higher even than last year's very favourable one. It is not yet clear, however, to what extent these increased grain supplies will result in higher exports or whether they will be absorbed within France itself.

Crops in Greece, Turkey and Yugoslavia

Turning to the other side of the medal, it is a matter for regret that the declining yields should have been experienced in countries for whose economies the grain harvest is of crucial importance, particularly Greece, Turkey and Yugoslavia. This means for Greece and Yugoslavia that it will be necessary to increase imports of wheat considerably during the year 1954-55. Indeed, the additional import requirement for Yugoslavia is expected to be of the order of 700,000 to 800,000 tons, which will represent a serious burden on an already strained economy.

Until the present situation clarifies, it is not easy to forecast the probable movement of Turkish grain exports during the season 1954-55. Although there is reported to have been a large carry-over from the last harvest, it is also stated that the internal situation has become difficult because farmers are holding back their deliveries to the State purchasing agency because of discontent with the current official price. The Government has replied to these tactics by arranging for ' shock imports ' of grain from the United States.

The coarse grain harvest

In general, the coarse grain harvest reveals a similar picture to that displayed by bread grains. Both France and Spain had a very large output, with declining totals in most other countries. Yugoslavia, however, had the compensation of a good coarse grain crop to offset the disastrous bread grain harvest. Taking Western Europe as a whole, the output of coarse grain may be about 2 million tons smaller than last year. Since the number of pigs has increased considerably in some countries, import requirements generally are likely to be higher than last year, even if some low-quality wheat is diverted to feeding purposes.

Conclusion

In sum, the ECE report suggests that, for Western Europe as a whole, import requirements of bread grain are likely to increase little, if at all, while somewhat higher imports of coarse grain can be expected. In any case, the ECE report concludes, the increase in Western European net imports will be small in comparison with the huge accumulation of stocks in exporting countries in other parts of the world.

GRAIN HARVESTS IN WESTERN EUROPEAN COUNTRIES
(in millions of tons)

Country	*Wheat and rye*			*Coarse grain*		
	1948-52 (*average*)	1953	1954	1948-52 (*average*)	1953	1954
Austria	0.69	0.92	0.84	0.61	0.85	0.80
Belgium	0.73	0.78	—	0.73	0.73	—
Denmark	0.65	0.61	0.55	3.39	3.81	3.65
Finland	0.46	0.35	0.42	0.92	1.24	1.10
France	8.36	9.45	10.56	5.38	6.62	6.66
Western Germany	5.70	6.46	6.89	3.92	4.63	4.50
Ireland	0.33	0.42	0.45	0.78	0.80	—
Netherlands	0.78	0.68	—	0.65	0.80	—
Norway	0.06	0.04	0.04	0.28	0.39	—
Sweden	0.94	1.31	1.36	1.70	2.19	1.86
Switzerland	0.29	0.31	0.32	0.13	0.14	0.14
Total: N.W. Europe	21.44	24.11	25.60*	23.43	27.63	25.75*
Greece	0.94	1.47	1.26	0.56	0.74	0.68
Italy	7.25	9.17	7.86	3.06	4.13	3.68
Portugal	0.67	0.81	0.91	0.62	0.57	—
Spain	3.77	3.47	5.02	2.72	2.70	3.30
Yugoslavia	2.41	2.82	1.85	3.69	4.63	4.60
Turkey	5.17	8.89	5.50	3.35	4.67	3.90
Total: S. Europe	20.21	26.63	22.40	14.00	17.44	16.75
Grand Total	41.65	50.74	48.60*	37.43	45.07	42.50*

Note.—The 1954 figures exclude mixed grain, except in the case of Denmark and Sweden.

*Including estimates for countries the harvest of which is not specified in the table.

Spray Irrigation

T. K. CORDES

Landsborough Findlay (S.A.) Ltd.

THE increasing world population makes increased food production a problem of international importance. As agriculture is the basis of all foodstuff production, any development which increases the productivity of the soil is a step towards avoiding conditions in which people, and animals, may be reduced to a state of undernourishment. But it is not only in foodstuffs that the need for increased agricultural production is imperative. More and more other products of the soil will also be required if our standards of living are to be maintained and those of peoples in undeveloped areas improved.

Part of the answer to the problem lies in the efficient utilisation and distribution of water. In many tropical and sub-tropical countries, the authorities are carrying out vast networks of dams and other water conservation projects, but the existence of catchments, dams, reservoirs and canals does not necessarily bring the water where it is most needed, *i.e.* to the crops, and at times novel methods must be adopted to ensure that the water is used economically and to the greatest advantage.

Present methods

Two principal systems of crop irrigation are in current use:

1. Flooding, in which water is allowed to flow freely over the ground or via furrows between the rows or plants, a system which has undesirable features; and
2. Overhead spraying, by means of which rain is simulated at will, as required, and applied in variable quantity from light drizzles to heavy showers.

It is well known that if timely showers fall during the period of crop growth, yields are higher and crops mature quicker than if they are 'reared' on flood-deluged tracts which use large quantities of water. Reports from the Thal and Hissar areas of the Punjab in India state that with timely rain kharif and rabi crops give higher yields than with flood irrigation.

Throughout the world, spray irrigation is attracting increased attention as an alternative to flooding in applying irrigation water to crops.

Where overhead spraying is practised, the increased crop yields in some cases are reported to be as high as 100% over those obtained with flooding methods. With regard to water consumed, Karl Loux, a German authority, has stated that by using artificial rain only one-tenth of the quantity of water is necessary to obtain the same results as are obtained by flood methods.

In Rhodesia, the consumption of water for cotton crops by overhead spraying is estimated to be only 25% of that used by flooding. It seems, therefore, reasonable to claim that for the same water consumption at least twice the acreage can be watered by spray methods as by flooding. Spray methods are, in fact, the nearest approach to natural rain as yet devised, with the advantage that water can be controlled, 'turned on and off,' as necessary, thereby effecting economies in time, water and supervision. The system and its appliances are extremely flexible, ranging from rotary and sector rainers for operation at high nozzle pressures to sprinklers, for use in smaller areas, at low and medium nozzle pressures.

Equipment can be obtained in various sizes and types to suit all requirements either as permanent installations or as portable single units, or arranged in networks which can be readily extended. Each installation must, of course, be considered in the light of the following factors:

1. The area to be sprayed, its shape and contour.
2. The position and type of water supply.

Fig. 1. Rotary rainers spraying crops in Central Africa

Fig. 2. Piping can be easily carried by one man from place to place

3. The quantity of water available.
4. The highest elevation to be sprayed above the main water level.
5. The furthest distance to be irrigated from the source of supply.
6. The power supply available.
7. The type of crop, the nature of the soil, and the 'periods' of rain required per week or month per acre.

Generally, an installation comprises two main groups, *viz.* (*a*) the pumping unit and (*b*) the piping, rainer or sprinkler units. Single-stage or two-stage centrifugal pumps coupled to a diesel, petrol or paraffin engine can be supplied for stationary use or as self-contained mobile units, or the pumps can be arranged to be driven from the user's own tractor or engine (Fig. 3).

Light-weight piping in aluminium alloy or galvanised steel is made in convenient lengths with ends arranged for quick coupling and release through the medium of non-leaking clamps. Up to 20° deflection at the joints in any direction is possible to suit irregular contours (Fig. 2). A full range of bends, tee-pieces and reducers is usually available to meet all requirements.

Fig. 3. Portable 'Landspray' pumping unit attached to a 'Hanomag' tractor

The high-pressure rainers atomise the water. They are made in a variety of types and sizes: the rotary types are capable of showering areas up to 400 ft. in diam., *i.e.* approximately 2.2 acres, with a water consumption up to 25,000 gal. per hour at each outlet. A number of rainers can be operated together from one pipeline and a uniform rate of deposition of water can be obtained up to 1 in. of water per hour per rainer. In places where full-circle rotary rainers are not suitable, long-range sector types can be used. The arc of distribution and water trajectory can be easily adjusted and, if needed, the sector types can be converted immediately into full-circle rainers. At a pressure of 132 p.s.i. an area of 6 acres can be sprayed with .315 in. per hr. (715 gal. per min.) on a jet range of 288 ft.

Low- and medium-pressure sprinklers

For small orchards, gardens, pastures, lawns and the like a range of low- and medium-pressure rotary sprinklers is marketed. The low-pressure units operate at between 15 and 30 lb. pressure per sq. in. They have a jet coverage of from 60 to 80 ft. diam. and discharge from 4 to 9½ gal. per min. The medium-pressure sprinklers are designed to operate at pressures of from 25 to 40 p.s.i., with a jet coverage between 88 and 115 ft. diam., discharging from 6.25 to 14.3 gal. per min. Typical graphs for two medium-pressure models are shown in Fig. 4. The curves are based on the sprinklers being mounted 2 ft. above the ground and supplied by 4-in. piping. The pressures given are those in the pipe.

The high-pressure rotary and sector rainer and the low- and medium-pressure sprinklers are designed for multiple use, the flexibility being such that the spray from the units can be arranged to overlap, thus avoiding dry spots. The precipitation tapers off at the outer circumference of the watered area so that there is no 'double dose' of water from an overlapping spray. Water is distributed evenly and therefore only the minimum is used (Fig. 5).

Operation and cost

The wide-scale adoption of overhead spraying depends chiefly on the relationship between the initial and working cost and the results achieved.

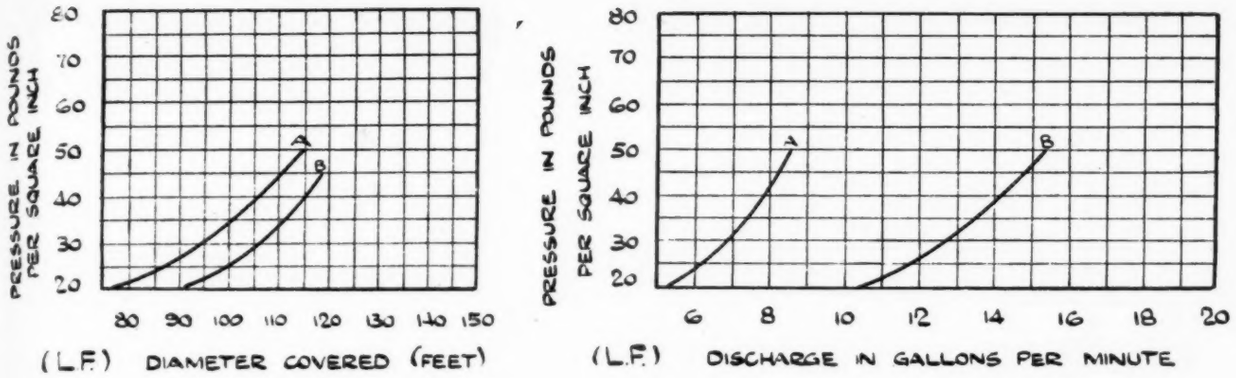

Fig. 4. Performance graphs for medium-pressure 'Landspray' sprinklers, Models A and B

In Germany, the spray method was first developed to ensure greater production from vegetable gardens, but today it is used extensively for watering major crops. In America, the system was originally used in California, but now it is practised widely in almost all other states at an estimated working cost of $0.75 per acre-inch.

Little data is available from India and Pakistan, where water is supplied to farmers at a very low rate and, thanks to the numerous irrigation networks, irrespective of the quantity used. Moreover, if a crop does not yield more than 25% of normal, no water rate is charged at all.

Recent installations

As an indication of the cost, a brief description of some recent installations is given below. In cases 1 and 2 the farmer's own tractors were utilised.

A 'Landspray' pumping unit was attached to a 45-h.p. tractor and, using one 'Landspray' M52 large rotary rainer, coupled direct, an area of 180 acres of cotton and mixed crops was irrigated on a jet radius of 200 ft., putting down 1 in. of water per acre per month. This equipment cost £350, therefore the capital investment represented less than £2 per acre.

2. A 20/25-h.p. tractor was fitted with a 'Landspray' pump serving two 'Landspray' M46 medium rotary rainers. In this instance, with a 250-ft. run of light-weight piping, 40 acres of potatoes were given 2 in. of water per acre per month. The complete installation cost £290. A heavily increased crop on a high-priced market product was the result for a capital charge of only £7 per acre.

3. In this instance 200 acres of cotton had to be spray-irrigated with 1½ in. of rain per acre per month, and an adjacent 400 acres were to be converted from the flood to the spray system. Assuming the yield to be only 25% more, the production from the 600 acres would be equal to that from 750 acres irrigated by flood methods for only half the water consumption.

This 'Landspray' installation consisted of a diesel-engined high-pressure mobile pumping unit mounted on a four-wheeled pneumatic-tyred chassis and 1,160 ft. of 4-in. piping with rainers and other accessories. The price was approximately £2,500. An optional standby set of piping was included, so that when one area was being watered the standby set could be laid in position for supplying an adjacent area ready for the transfer of the pumping unit. The advantages gained by having a duplicate set of piping, etc., on large farming tracts will be seen. The cost of this installation spread over 15 years would be $\frac{£2,500}{600 \times 15}$ *i.e.* 5s. 6d. per acre per annum.

Conclusion

From the foregoing the potentialities of overhead spray irrigation can be estimated. Throughout the world, huge sums are being spent on water conservation projects and the next stage is to ensure that the water conserved is utilised in the most efficient manner. Scientific research has shown that overhead spraying is the most effective and economical method ensuring the maximum production from the land with minimum consumption of water.

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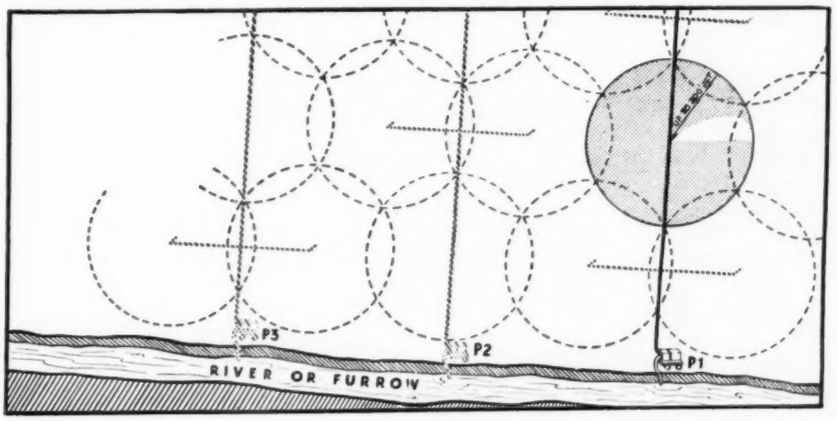


Fig. 5. Diagram showing coverage afforded from different pumping stations

Myxomatosis and the Rabbit Problem in Australia

This article on myxomatosis in Australia is based on a report by Mr. F. N. Ratcliffe, officer-in-charge of the Wildlife Survey Section of the Australian Commonwealth Scientific and Industrial Research Organisation, and has been made available to us by the Australian News and Information Bureau. Myxomatosis in Britain was discussed in an article by Dr. C. H. Andrewes in our December 1954 issue.

AUSTRALIAN landholders will have to accept the fact that myxomatosis will not provide a final solution of the rabbit problem. The disease will merely assist towards a solution which must be attained by human effort planned and carried through on individual holdings. The survivors of myxomatosis outbreaks must be destroyed by standard methods.

It may seem strange that the success of myxomatosis should precipitate an argument on the wisdom and soundness of two flatly opposite policies. The official policy is to encourage the intensification of control by standard methods and to consolidate the gains accruing from myxomatosis by mopping up surviving rabbit infestations. This policy was decided on after careful consideration of the facts and probabilities: it is supported by representatives of all states and is emphatically endorsed by the specialists. Its rejection would probably be a national calamity.

The outcome of the present situation depends on the action taken by individual landholders; regulations can never enforce action beyond a certain point and rabbits will never be eradicated from a holding, or effectively controlled, unless the owner is personally convinced that the job is sufficiently important to justify a high priority call on his resources and is determined to see it through.

Rabbit resistance

It is wrong to assume that the wild rabbit population will never acquire some degree of natural heritable resistance to the virus. The reverse is almost certainly true, and the only thing which now seems uncertain is the number of years' grace that will be allowed before this resistance develops to a level at which the efficiency of myxomatosis as an agent of control will be significantly affected. The danger of the rabbit's progressive adjustment to the virus has only recently been brought into clear focus, *i.e.* since the C.S.I.R.O. Animal Genetics Section demonstrated that the rabbit possessed heritable factors affecting its susceptibility to myxomatosis on which selection could work.

At a recent myxomatosis conference in Melbourne, Dr. J. M. Rendel warned that the development, in the wild rabbit population, of some degree of intrinsic resistance to myxomatosis is inevitable; that the process of building up this resistance through selection, though at first likely to be slow, would increase in tempo; and that it would be enhanced by the prevalence of attenuated strains of the virus which permitted an increased percentage of rabbits to recover from the infection. While he obviously could not be definite in his prognostications, Dr. Rendel made it clear that he was talking of changes to be expected in the near, and not the distant, future.

Other factors

Three things will progressively restrict the efficacy of myxomatosis as an agent of control, locally or seasonally. The development of a resistant rabbit population has already been dealt with. The other two factors—inadequacy of insect vectors and a decrease in virulence of the virus—are much more definite and their effects are already observable.

Although every year outbreaks of the disease have occurred which we cannot tie up with obvious insect activity, the main pattern of myxomatosis performance in South-Eastern Australia reflects very closely, in time and place, the seasonal activity and local abundance of certain species of mosquitoes. The vector (insect carrier) situation will determine the percentage

Ravages caused by rabbits are clearly evident in this photograph taken at Balranald, New South Wales

of the local rabbit population that acquires the infection and therefore the maximum possible mortality.

The position can best be summed up as follows: There are certain areas in Australia where the right mosquitoes are sufficiently abundant every year to produce something very close to 100% infection of the local rabbits, but these areas are a small fraction of the total rabbit-infested country. Elsewhere, one finds a range of conditions, from country where good kills may occur in most years—or, at any rate, with fair frequency—to regions where they can only be expected in an exceptional season, such as will only occur once in a decade or more. Thus, even in the relatively well-watered eastern highlands there are districts which have only had the benefit of one useful kill in the four years during which the disease has been active in the country. This was in the 1952-53 season, which revealed the high-water mark of myxomatosis performance in South-Eastern Australia.

A decrease in the virulence of the virus will also ' lower the ceiling ' of the maximum possible kill that myxomatosis can effect.

Prof. Fenner's investigations at the Australian National University have shown that strains of the virus with a reduced virulence have appeared as a result of spontaneous variation and that these are now widespread and look like becoming generally dominant. There are two questions of importance in relation to this matter of decreasing virus virulence: first, what it means in practice; and second, whether, and how far, it will continue beyond the present stage.

Attenuated strains that are now prevalent will kill about 90% of infected animals, as compared with the case mortality rate of over 99% produced by the original ' standard ' strain of the virus.

There is a material difference, in practice, between the fully virulent disease ripping through a completely susceptible population (as occurred in the early outbreaks) and the resurgence of an attenuated strain in an area where a proportion of the rabbits are recovered-immunes that survived the previous season's epidemic. Taking into account these immunes, and the fact that a 100% infection of susceptibles is exceptional, one would be lucky to get much more than an 80% kill in a local rabbit population in the circumstances.

Another example of action by rabbits, this time at Lake Tooin in New South Wales. (*Below*) The same area three years later. A wheat crop is nearly ready for harvest, as rabbits are under control, although not completely eradicated. Control has resulted from myxomatosis and more conventional methods, such as poisoning and trapping

In the interval between epidemics the survivors could stage a very substantial recovery if conditions are reasonably favourable for breeding. Thus, measured by the average number of rabbit mouths grazing on an area over the year, the reduction of an infestation by the operation of a strain of myxomatosis with a 90% case mortality rate would be very much less than 90%. If the virulence of the dominant strains of the virus slipped back to 80% level, the value of the disease as a controlling agent would be virtually lost.

Very little can be done to mitigate the factors restricting the control value of myxomatosis. Mosquito abundance is determined ultimately by the continent's climate and the ' luck of the seasons.' The danger of increasing resistance in the rabbit population can only be countered by destroying the survivors of myxomatosis outbreaks by standard methods.

Conclusion

It is essential that landholders should realise that the danger of myxomatosis

providing progressively less and less assistance in the fight against the rabbit is very real. Even now the disease is not controlling rabbits so effectively that we can afford to relax and not back it up.

The netting of individual properties is an essential prerequisite to clearing rabbits off land and keeping them off; and it always will be until effective co-operation between groups of landholders can be developed. Even in regions that have benefited most from myxomatosis the eradication of rabbits still remains a difficult and costly business. The disease, however, has helped in two ways: it has done a good part of the essential initial killing-off, and it has improved the financial position of primary producers, rendering them better able to meet the costs of mopping up. More important still, it has provided a large-scale demonstration of what the land can grow in the way of pasture when the pressure of the rabbit has been removed. Having seen this, it seems to me that every landholder should regard it as his duty to Australia and to the rising generation to do all that is feasible to transform this potential productivity into a permanent asset.

An old print of Johann Rudolf Geigy and his son, Hieronymus. It was originally believed that he founded the famous company of dyestuff and chemical manufacturers in 1764. Recent researches, however, show that it was founded six years earlier, in 1758

N.I.A.B. Crop Conference

THE National Institute of Agricultural Botany's Third Crop Conference was held in Cambridge on December 14 and 15 and was attended by well over 300 farmers, merchants and millers and by advisory and technical officers.

Part I—Crops for home feeding

The proceedings opened with a valuable survey of the oat crop by Prof. E. T. Jones, the Director of the Welsh Plant Breeding Station, and who was personally responsible for breeding Milford, Maldwyn, S.147 and other oats. Oats have shown a definite increase in average yields during the present century, but many crops still give very low yields. He emphasised the dependence of the oat on the hours of sunlight available for the production of high yields; as a result delay in sowing after March has been shown to cause a reduction in yield of $\frac{1}{4}$ cwt. for every day of drilling. He drew attention to the unexpected failure of very early varieties in upland areas, perhaps because they do not there find sufficient fertility to compensate for the shorter growing period.

Mr. E. G. Thompson, Head of the Crop Improvement Branch of the N.I.A.B., returned to this point in his lucid survey of recent trials results, which have suggested that a medium early variety, such as Maldwyn, will almost always outyield the very early varieties by a comfortable margin. Sun II had done particularly well in trials of spring varieties and appears to be adapted to a wide range of conditions in this country, and is a safe recommendation for general purposes.

Discussing winter oats, he pointed out that S.172 has the best resistance to lodging, but is lower yielding than S.147. To choose S.172 for conditions where S.147 might have stood involves perhaps a 10% loss in yield of grain and straw. By overdoing the fertiliser even S.172 will not stand. Adding the uncertainty of the British climate, there was plenty of scope for exercising judgment in choice of variety.

Mr. Herbert Lea, Vice-Chairman of N.I.A.B. Council, and a prominent oatmeal miller, drew attention to the many definitions of oat quality according to the point of view. The provender miller was concerned with fat, protein, fibre and moisture content; the oatmeal miller with the extraction of first quality oatmeal, and the housewife with flavour and cooking qualities. Recent research had improved the keeping quality of oatmeal, opening the way to many new uses. Even the millers' waste had its value. Oat husks could be used to produce a solvent of strategic importance, and research was going on into use as adhesives, polishes and abrasives.

Dr. C. C. Balch, of the National Institute for Research in Dairying, and Mr. Lea both drew attention to the high fat content of oats and to wide varietal differences.

Dr. Balch pointed out that costings show that starch equivalent from home-grown oats it not much more expensive than from silage and hay, and is cheaper than from kale or mangels, so that it represents a concentrated feed at the price of a roughage. During the discussion Dr. Balch mentioned that the quality of 'fibrousness,' though very difficult to measure, seemed important to the cow and oat straw could be useful in contributing this factor to the diet.

The importance of correct husbandry in determining the success of the crop was re-emphasised by Dr. Hunter.

Part II—Grasses and clovers

The second part of the conference was devoted to grasses and clovers and was opened by Prof. T. J. Jenkin, this year's chairman of the N.I.A.B. Council and formerly Director of the Welsh Plant Breeding Station. He gave a fascinating account of the development of indigenous and 'bred' strains, and in particular of his own work in breeding many of the Aberystwyth strains from single plants, or small collections he had made in many areas.

He was followed by Mr. R. P. Hawkins, who spoke of the work the N.I.A.B. are carrying out on the classification of strains of grasses. Most species can be divided into early and late types, classification of value to the farmer. He referred, too, to trials results which had demonstrated how

the early strains of perennial ryegrass gave earlier growth than the later strains, which in their turn continued growing after the earlier strains had slowed down.

Dr. William Davies, Director of the Grassland Research Station at Hurley, spoke of the utilisation of grass and of grass strains. He suggested that the leys based on leafy strains could be very flexible and could offer seed for many more months than had hitherto been thought possible. Commercial types of seed mixtures could make the farmers' problems more acute because they produced stemmy, fibrous growth in spring at such a rate that no farmer could hope to cope with the excess grass. Dr. Davies said that, in his opinion, the yield aspect of herbage plants could be over-emphasised. There was a greater need for the integration of strains and of species so as to provide animal feeding from grass for every week of the year.

Mr. A. F. Kelly spoke of some international trials which he was helping Mr. F. R. Horne, Director of N.I.A.B., to co-ordinate on behalf of the Organisation for European Economic Co-operation. These trials of five species of grasses and clovers are to be conducted in more than 15 European countries and should make it easier to tell which strains are most suited to particular areas.

He also referred to a second OEEC project, with which the N.I.A.B. is concerned, to clarify the terminology used in seed certification schemes.

In the last paper of the conference, Mr. G. W. G. Briggs, Head of the Seed Production Branch of the N.I.A.B., spoke of some of the principles to be observed in the production of high-quality seed of herbate strains. Certification schemes aim to achieve uniform standards of seed quality in which the purchaser can have confidence and which reproduce those characteristics on which the strain has gained its reputation. They are not an end in themselves, but play their part in the general agricultural production of the country by providing high-quality seed adapted for particular requirements.

During the ensuing discussion, Dr. William Davies was asked to expand on the possibilities of winter grazing. He stressed that if the pasture could be rested in autumn to get the maximum growth of top and of feed stored in the roots and leaf base, the field could go into the winter with a mass of herbage. If grazed once only, this could be completely removed during the winter without retarding early spring growth. But if stock were left to eat each plant a second time this could only be done at the expense of food reserves and of subsequent spring growth.

Mr. F. R. Horne, Director of N.I.A.B., summed up the proceedings. The papers had proved that the oat crop was by no means a Cinderella among the cereals. The problems of late sowing due to bad tilth, eelworm and low fertility could be overcome by the proper use of leys, while good arable cultivation helped to improve subsequent grass crops. The speakers had given a very challenging picture of crops for home feeding and of the opportunities for improving them.

The proceedings ended with votes of thanks to the chairmen of the two sessions, Mr. Roland Dudley and Mr. Sam Taylor, and also to the N.I.A.B. for organising such an enjoyable and instructive conference.

Bunt Control Bulletin

Reviewing a recently developed, non-mercurial seed disinfectant specially designed for effectively controlling bunt on wheat at low cost, a new technical bulletin has just been issued by the Diamond Alkali Co. The bulletin, available in English or Spanish, points out that bunt causes American farmers alone an average annual loss of more than $25 million, and describes a recent Diamond development — Buntrol 40 — designed especially for economical bunt control.

Seven advantages provided by this improved, safe material are listed and its application manually or mechanically by dust or slurry methods outlined. Results of tests of Diamond Buntrol 40 and three mercurial fungicides conducted on spring and winter varieties of wheat by the U.S. Department of Agriculture are also given.

Copies are available on request to the Diamond Alkali Co.

Kapok

In our issue of February we published an article by Mr. A. E. Haarer on kapok, which included data provided by an unpublished report written by the late Dr. P. J. Cramer. We are now able to mention a communication from Ir. G. G. Bolhuis, of the Landbouwhogeschool, Wageningen, in which some additional information is given.

It appears that trials were made at the General Experiment Station at Buitenzorg in the late 1920s with a kapok tree which did not grow as tall as usual because the lower branches were not shed as the tree grew taller. The form was called the 'Lanang-type.' Since kapok trees are normally grown among other crops, neither the planters nor the peasant growers favoured the new variety, which took up too much room.

Plants were introduced into Malaya because it was thought that the new form would render harvesting much easier. Unfortunately, it was disliked for the same reason.

Buds taken from the lateral branches and inserted in a vertical stem will not make a new upright growth or a properly balanced tree, since they insist on making an awkward lateral growth. Cuttings rooted from lateral growth behave in the same manner.

IBAE Scholarships

The council of the Institution of British Agricultural Engineers have in their gift two scholarships for award to students undertaking the year of study leading to the final examination for the National Diploma in Agricultural Engineering. Both scholarships will be awarded for the session of study for 1955-56 and will be applied for the benefit of approved candidates for the final examination who would experience difficulty in undertaking full-time study at an approved college without financial assistance.

Full particulars, together with forms of application, may be obtained from the Secretary, The Institution of British Agricultural Engineers, 24 Portland Place, London, W.1. Closing date for receiving completed application forms is May 31, 1955.

Management for Milk

(*Above*) **Stacking turned hay on to tripods.** (*Below*) **Making silage, perennial rye grass being unloaded on to pit as the finish is reached**

Cutting and loading silage from a pit. Note the corrugated iron covering and beneath it the good depth of soil which have helped to keep rain-water from the silage

FOR a number of years past the Agricultural Organisation of Imperial Chemical Industries and its subsidiary, Plant Protection Ltd., have been in the habit of making films for showing to farming audiences the various aspects of husbandry.

Since 1946, the Agricultural Organisation of Imperial Chemical Industries has conducted a series of investigations into the economics of a large number of farms throughout the country. One of the most important aspects of these enquiries was to see how far better grassland husbandry could benefit both individual farms and the country as a whole. The results of these investigations have proved conclusively that grass is the cheapest of all foods for livestock and is the greatest potential source of profit on farms today and probably in the years ahead.

Much of the most important findings of these investigations will be published in due course in the form of bulletins by the Imperial Chemical Industries, but in 1953 it was decided to make a film which would be a pictorial record of one of these farms. This film has now been completed and given the title which heads this note. It was shown to an audience of members of the press on October 19 last.

The film tells the story of a year on a 95-acre farm in Sussex, where the farmer has achieved some remarkable results over the last seven years.

By hard work and good management milk production per acre has been raised and costs per gallon lowered. The grazing season has been extended to the limit of early spring and late summer and every effort has been made to feed grass, either as grazing, or as silage or hay, and as a result the purchase of feeding stuffs is kept to a minimum.

The film shows what can be done by careful planning and looking ahead. No lavish expenditure was made on equipment or buildings.

The main theme is that by treating grass as a vitally important crop and by producing, conserving and using it wisely the whole economy of the farm has been greatly improved and dependence on purchased feeding stuffs reduced to a very low point.

The Forest Plots at Bedgebury

J. D. U. WARD

ALTHOUGH the National Pinetum was founded at Bedgebury, two miles south of Goudhurst in Kent, in 1925 and the planting of the adjacent forest plots began in 1929, the place is not nearly so well known as it deserves to be. The pinetum is run by the staff of the Royal Botanic Gardens at Kew and is primarily (although not solely) of arboricultural or horticultural interest. But the forest plots are a silvicultural enterprise of the Forestry Commission's. They were established with the objects of (1) comparing the growth of different species of the less common conifers and broad-leaved trees planted in small blocks and grown under normal forest conditions and (2) studying the effect of source of seed upon the form and development of the more important, or more widely distributed, species.

There are rather more than 100 plots of ¼ acre each, with a few others slightly larger and of irregular shape round the periphery. Only a small selection of the major species, with two or three oddities, can be mentioned here.

Although the rainfall at Bedgebury is only 33 in., the plot of *Abies grandis* (the grand silver fir of North America) planted in 1931 and 1932 is one of the best in the collection. Heights of over 40 ft. were recorded in well under 20 years. Another reputed moisture demander, *Tsuga heterophylla*, the beautiful western hemlock, is particularly good.

Spruces

Of the spruces, *Picea Omorika* (Serbian spruce) is perhaps the most interesting. This species, which has a larger plot of 1½ acres, is indigenous to a quite small area in Yugoslavia; it was not discovered until 1875, nor introduced into Kew until 1889. It is happy with less rain than either Sitka or Norway spruce, which latter it resembles in many ways, but its habit is more slender.

The oldest specimens of the rather rare Leyland's cypress (*Cupressocyparis Leylandii*) were planted only eight years ago, but the plot, with trees of different ages, is well worth seeing. In the pinetum, by the way, are larger and older specimens of this extremely vigorous hybrid, whose parents are *Cupressus macrocarpa* and *Chamaecyparis Nootkatensis*. This new species may well be an important tree of the future.

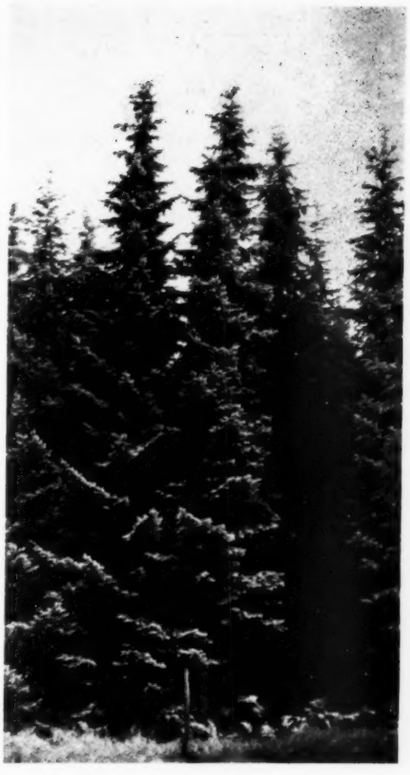
Larches

There are five plots of larches; in effect, a miniature races or provenance trial. The three plots of Scottish provenance are superior to those grown from Swiss and Silesian seed. With Scots pine, again, different races are represented. The plots of Danish and Belgian origin are superior to those from Scotland, Finland and Southern Norway. Worthy of remark is *Pinus peuce*, the five-needled pine from the mountains of Macedonia, which shows promise.

Hardwoods

Among the hardwoods, the three American red oaks (*Quercus borealis*, *Q. palustris* and *Q. coccinea*) are all good, and the southern beech (*Nothofagus obliqua*) from Chile has done very well. The few remaining *Nothofagus procera* should not be overlooked, although they have suffered from frost —and canker.

Four species of maples (*Acer*), two of alders (*Alnus*), three of cherries (*Prunus*) and four of birches (*Betula*) may be found. Among oddities are the tulip tree (*Liriodendron tulipifera*), which is, of course, an important forest tree and a large producer of commercial timber in its native U.S.A., *Cotoneaster frigida*, laburnum, and two buckthorns. It was originally thought that the *Cotoneaster*, which grows very slowly, might yield a good substitute for persimmon for the heads of golf clubs. Laburnum, a failure, was thought to be a possible alternative to ebony. Of the two buckthorns, *Rhamnus purshiana* from western North America is both the source of the purgative drug cascara and also a good raw material for the fine charcoal required for explosives. *Rhamnus frangula* (our indigenous alder-leaved



Serbian spruce (*Picea omorika*)

'Southern beech' (*Nothofagus oblique*)

buckthorn) is primarily a charcoal species.

Both the pinetum and the forest plots are set in the matrix, so to speak, of Bedgebury Forest (2,400 acres), which contains a promising 2-acre plot of *Cryptomeria japonica* (sometimes called Japanese cedar), well known as a garden tree in Britain, but almost unknown as a forest species.

An excellent half-crown guide to the National Pinetum and the forest plots, with sketch maps and plots plans, is published by H.M.S.O. It may perhaps be added, for the benefit of anyone projecting a spring or summer holiday visit *en famille*, that the pinetum is very pleasantly laid out and that its amenities include a small stream and a lake with water lilies. But there is no tea room or cafeteria anywhere near, so a picnic basket will be wanted in the car.

Tulip tree (*Liriodendron tulipifera*)

European Agriculture in Southern Rhodesia

Between the 1949-50 and 1953-54 seasons the value of the total output of European agriculture in Southern Rhodesia rose from £24,565,000 to £33,386,000. Of the latter figure, tobacco accounted for 57·7% (£19,264,000), maize for 15.1% (£5,038,000), cattle for slaughter for 11.3% (£3,750,000) and dairy produce for 3.8% (£1,280,000). In the same period, the total operating expenditure increased from £15,578,000 to £22,186,000. The largest item in operating expenditure was African wages (cash and kind), which rose from £4,930,000 in 1949-50 to £7,300,000 in 1953-54, or 21% of the total. European wages rose from £2,216,000 to £2,850,000. The realised income of farm operators reached the record level of £11,200,000 in 1953-54, compared with £8,987,000 in 1949-50. These figures are quoted in a report on the input and output of European agriculture in Southern Rhodesia, published in the Monthly Digest of Statistics by the Central African Statistical Office. In an appreciation of the 1953-54 season the report says that the outstanding feature of the 1953-54 season was the number of records which were established. The value of the output of tobacco rose from £17,434,000 in the 1952-53 season, the previous record figure, to a new record of £19,264,000. The value of maize available for sale and human consumption on farms totalled £5,038,000, which exceeded the former record of £4,966,000 established in the 1951-52 season. The value of cattle for slaughter and dairy produce also reached new maxima of £3,750,000 and £1,280,000. The value of other crops and livestock amounted to £2,610,000, which was only £70,000 less than the record of £2,680,000 which was realised in the 1951-52 season. As a result of these changes and an increase in income in kind produced and consumed on farms, the total value of output was £33,386,000, the highest figure ever reached. The total value of output in the 1953-54 season was 10.4% higher than in the 1952-53 season and exceeded the previous record established in the 1951-52 season by £2,278,000, or 7.3%. As a result of the greater increase in the value of output than the value of input, the realised incomes of farm operators reached a record figure of £11,200,000, an increase of £1,949,000, or 21.1%, as compared with the 1952-53 season and 3.5% higher than the previous record of £10,821,000 realised in the 1951-52 season.

Shell Agricultural Research

All the agricultural research work carried out by the Shell Group in their laboratories at Amsterdam and Thornton, Cheshire, is to be transferred to the Shell Agricultural Research Centre at Woodstock Farm, near Sittingbourne, Kent, where extensions to facilities at present in progress will cost £150,000.

Hitherto the main emphasis at Woodstock Farm has been on experimental research into the potentialities and practical value of chemicals synthesised at Shell installations elsewhere, often at the request of Woodstock staff, but when the new facilities are complete, synthesis and analysis will be done on the spot and it will be possible to produce, more quickly, trial quantities of chemicals in accordance with the ideas of workers engaged on particular problems of insect, fungus or weed control. Bearing in mind the seasonal nature of some of these problems, the time saved in this way will be extremely valuable.

The new buildings will comprise three new laboratories, increasing laboratory space fivefold from the present 4,000 sq. ft. to 21,000 sq. ft., an administration block which will include a new conference room and library, a new engineering workshop and two additional glasshouses. The present staff of 32 will be increased to nearly 100.

Despite its technical and scientific background, Woodstock, which was bought by Shell in 1945, is run as a farm, and of its 254 acres 170 are cropped for the production of cereals, hops and fruit. The requirements of research have priority in the farming plan, but, thereafter, the farm operates as far as possible on normal commercial lines.

South African Agricultural Developments

WE have received from our Cape Town correspondent the following recent news of agricultural developments in the Union:

Rooibos tea prospects

Rooibos tea has been declared a product for the purposes of the Marketing Act and a scheme for regulating the production and marketing of this 'tea' has been gazetted. The scheme is the outcome of control proposals which originated from a co-operative society. At the outset, the idea was opposed by rooibos tea packers and many farmers. The only area in the world where it is grown—it is now a cultivated product—is between Citrusdal and Nieuwoudtsville. Clanwilliam, the centre of this region, is the main producing centre. Nearly all the tea comes from the Cedarberg range and from small ranges running parallel to it.

Production is now between 1.5 million lb. and 2 million lb. a year. This is higher than it has ever been in the 50 years since the industry started. Mr. H. C. Ginsberg, chairman of the Cape Rooibos Tea Packers' Association, said that more people than ever before were drinking rooibos tea, but the demand was slightly below output. Prices had remained fairly constant for the last eight years. He did not think the introduction of the control scheme would bring about an immediate increase in retail prices, but no one could say what the future held in store. Many people were still prejudiced against rooibos tea. Many confused it with bush tea, which grew in most parts of the Union and was much cheaper. Generally, the taste for it was acquired. It was more like China tea than Indian-type tea. In the next year or two, experiments would be made with the aim of making its taste more widely acceptable. At present, rooibos was sun-dried where Indian-type teas were fired after fermentation to dry them. In tests to be made, rooibos tea would be artificially dried by firing.

With the introduction of the control scheme in November, nobody may now sell rooibos tea in the Union unless it is packed or marked according to grade and in a way prescribed by regulation. Rooibos tea means the product obtained from the needle-like leaves and fine stems of the plant *Aspalathus contaminatus* (*Thb.*) *Druce* (*Borbonia pinifolia Marl.*) or related species after it has been cut, bruised, properly cured and dried. The control scheme provides, among other things, for the creation of a Rooibos Tea Control Board of nine members appointed by the Governor-General. The board may buy and sell rooibos tea or withhold from the market part of the rooibos tea it has bought. It can, with the approval of the Minister, prohibit anybody from selling rooibos tea not acquired from it or from persons determined by it. If the Minister approves, it can impose a levy of not more than ½d. a lb. on any class, grade or standard of quality of rooibos tea, as well as a special levy. Nobody who produces rooibos tea in the magisterial district of Clanwilliam, Calvinia, Piketberg and Vanrhynsdorp may sell it unless he has been registered with the board.

Peppermint oil prospects

Thirty acres of peppermint oil plants are now growing on a farm in the Bloukrans Valley near Weenen in Northern Natal—a pioneering venture in a crop which has rich prospects in the Union. The venture was organised by a Weenen farming company which obtained the services of a Hungarian peppermint expert, a refugee from his homeland who had escaped from behind the Iron Curtain with a few plants taken from his former estate. Propagated from the tiny store of original plants, the peppermint plantations are now growing well and may in the very near future yield a marketable crop of this valuable oil. South Africa has had to import all its peppermint oil used for flavouring in sweets and certain medicinal purposes. If the Weenen venture is the success now so confidently anticipated, Natal may soon become the chief supplier of the Union's peppermint needs.

Fruit growing

Vineyards and orchards in the principal fruit-growing districts of the Cape generally benefited from the wet wintery weather and are now giving good yields. Estimates of the yields have still to be published, but prospects for the new season are favourable. Shipping and overseas marketing arrangements are unchanged from last season, but it is felt that prices may recede slightly as a result of probable competition from the United States and Canada on the overseas markets.

Barley difficulties

Government action cost the Wheat Board a loss of £40,000 on barley exports last year, says the board's report for 1952-53. When the Wheat Board wanted to export its barley surplus, the Department of Agriculture refused because of the maize shortage and insisted that the surplus be sold to the Maize Board at the South African fixed price. After buying 142,000 bags of barley the Maize Board (no doubt because a bumper maize crop was now in sight) found it could buy no more. The Wheat Board had to export the remaining 148,000 bags, which by now were beginning to be infested with weevil. To make matters worse, the overseas price collapsed. Describing its loss of £40,427 on that export as 'unnecessary,' the Wheat Board says that, as it was 'due directly to the Government's action in refusing the board permission to export early in the season, it should have been borne by the Government.' The board had had to meet the loss itself from its barley reserve fund.

Tobacco crop

The South African tobacco crop is likely to be reduced this year because of lack of early rains in the Brits, Marico and Rustenburg regions, which produce about 90% of the Union's flue-cured tobacco. In these areas, tobacco is grown by irrigation and the almost empty dams, including Hartebeestpoort, have given growers a big problem.

There is a bright patch at Groblersdal, where the Loskop Dam, which feeds the tobacco lands, is filled to 70% of its capacity. It seems obvious that the total acreage under tobacco in drought affected areas would be reduced compared with last year, when the crop was middling to good.

(Left) **The grain market in Tangier. The grain is displayed in front of the wooden booths in palmetto fibre baskets and sacks.** *(Right)* **Moorish women beating out the grain with crude olive wood clubs**

Agriculture in Tangier

(From a Correspondent)

IN the French Zone of Morocco, the natives, with the help and example of the French colons (farmers), are beginning to learn the use of fertilisers, tractors and other modern ways of farming, but around Tangier it is different.

Although the international town of Tangier has a modern quarter, yet only a couple of miles outside the town the natives still till, sow and harvest their crops in the same old way. Any suggestions made by Europeans are looked on with suspicion, and the old ways are still thought best, because as yet there has been little effort to demonstrate the contrary.

More land each year is ploughed and cleared of the stunted palmetto, but the earth is only scratched with a wooden plough drawn by a couple of thin oxen or sometimes a horse and donkey. No effort is made to prevent erosion; the same land is used for the same crops, chiefly long-eared wheat, at the beginning of summer and millet in September, year after year, the only fertilising being the droppings of the cattle and goats that are turned into the stubble during the rest of the year.

Harvesting is slow, each family turning out to cut by hand sickle and beating out the grain by means of heavy wooden clubs. Horses driven round and round are also used. The grain is then tossed with wooden forks and later poured into woven panniers of palmetto fibre and taken into town, where it is sold in the local grain market. The harvesters are still paid as they were in Biblical times, by receiving at the end of each day their portion of the grain, their gleanings being reserved for the ploughman's or ploughmen's wives.

Grain is sold by the ' toumini,' a native measure of roughly 13 pints (6½ kg.), and the present price of corn is approximately 4s. 6d. per ' toumini,' but the price varies with the season. The natives all make their own bread and no grain is exported.

East Malling Research Station Members' Day

At this season, pruning is a topical subject in which fruit growers' interest was shown by an attendance of 200 at the members' day on Thursday, November 25. After the visitors had been welcomed by the Director, Dr. F. R. Tubbs, their attention was drawn by Dr. W. S. Rogers to the different pruning requirements of experimental and commercial orchards.

Mr. A. P. Preston demonstrated the pruning of newly planted trees and described the two extensive pruning trials at present in progress on trees planted in 1945-46. These provided comparisons between open centre, delayed open centre and regulated trees and between renewal and spur pruning. Members were shown the pruning methods used and the crop from trees receiving the different treatments. They also saw some trees that had been deblossomed for six years after planting. Mr. Preston discussed the effects of the treatments on cropping, fruit size and quality. As the trees were as yet only 10 years old, it was obvious that the results described might need to be evaluated afresh in the future.

After lunch, Mr. R. J. Garner showed trees some of which 20 years before had been topworked by various methods and others frameworked. The performance of the frameworked trees had been much better than that of the topworked trees, quickly repaying the extra initial cost involved. The pruning of reworked trees was also described.

Fisons Pest Control, Ltd.

As from January 1, Pest Control Ltd. changed its name to Fisons Pest Control Ltd. The company will continue to trade independently as previously and its headquarters will remain at Bourn, Cambridge.

NEW BOOKS

Means of Increasing Rice Production

By J. G. de Geus. Pp. 143, illustrated and maps. Centre d'Etude de l'Azote, Geneva, Switzerland. 1954.

This excellent compendium of present knowledge on paddy cultivation does not claim to be a complete handbook on the subject. The earlier sections give brief particulars about world rice shortage and also deal with varieties of rice, cultural methods, tillage and water supply. The importance of nitrogen for rice growth is emphasised and information given concerning time and method of application and the most suitable form for the crop. The author then deals with phosphate, potash and trace elements in rice cultivation, green manuring, the pretreatment of seed and seedbed manuring, plant breeding and the control of pests and diseases. The remainder of the book is devoted to brief accounts of rice production in different parts of the world, particular attention being drawn to results of fertilising experiments in each country and the extent to which manures and fertilisers are customarily used.

The conciseness of the text calls for an ample bibliography and in this the book does less than justice to the enormous amount of literature on the subject. Furthermore, the references are, in many cases, incomplete, titles being given but their sources not stated.

The author stresses the possibilities of increasing rice production by means of efficient fertilising without neglecting or under-estimating the importance of factors that contribute to higher yields and often form the basis for maximum fertiliser response. He concludes that one of the most promising methods of increasing yields in the tropics is by the extension of the practice of intensive manuring, judiciously combining the use of green manure with local fertilising materials and commercial fertilisers. While one may readily accept this view, he gives one the impression that there are no complexities in connection with paddy manuring, whereas, in point of fact, the subject bristles with unsolved problems; knowledge of paddy soils is very incomplete and the response to fertilising so unpredictable that a preliminary trial is usually necessary before venturing on a recommendation.

There is no mention of the unsatisfactory economic position of many Asian cultivators, although this is a most important factor affecting the area cultivated and the yield per acre. The problems of unsatisfactory conditions of tenancy, antiquated laws of inheritance and financing cultivators must be solved and until this is done interest in improved methods of production and higher yields will be lukewarm.

This beautiful book, printed on excellent paper and enhanced with about 50 illustrations and a number of maps, is published by the West European Nitrogenous Manufacturers, who in 1953 founded the Centre d'Etude de l'Azote with the object of making scientific and practical study of the methods which may assure rational and increased use of nitrogenous fertilisers. Rice was chosen as the first study because it is the principal food for more than half the world's population and the well-being, standard of living and prosperity of so many countries are dependent on this commodity. The author and publishers are to be congratulated on the excellence of this book, which should go far to achieve the object for which it was written.

D. H. GRIST

The Villiers Engine for Industrial, Agricultural and Horticultural Use

By B. E. Browning. Pp. 148. London. C. Arthur Pearson. 1954. 6s.

This is a practical handbook for the servicing and maintenance of Villiers two-stroke and four-stroke industrial engines. It will be valuable to owners and users of such engines in helping them to obtain good and economic performance. The book is written from a strictly practical point of view and is profusely illustrated with diagrams of working parts.

A useful feature of the book is the fault-finding charts, which will be found invaluable to the engine owner when, as is the habit of all engines, it develops strange, disconcerting and inexplicable maladies.

Two Acres Unlimited

By Carola Cochrane. Pp. 134. London. Crosby Lockwood. 1954. 10s. 6d.

'If money was no object I should cover the greater proportion of my land with frames and cloches and entirely discontinue the growing of such crops as cabbage, sprouts, leeks, etc.' So writes Carola Cochrane in this book. This is sound advice for all who contemplate market gardening on a small acreage, because it is not possible to earn a living on a limited area unless the crops grown are such as to bring in high returns per acre.

One can thoroughly recommend this book to all those who intend to take up intensive market gardening and also to those who are now engaged in such work. One does not remember ever having read practical information set out in such an agreeable manner. We had to read the 134 pages at one sitting. It reads like a novel and yet it is a valuable book of reference.

In the main, the advice given is sound. One learns how the author started to reform a grass field into a highly productive intensive market garden. We read of her successes and failures. How, having mastered two acres, she gradually extended her acreage to four; finding that the increased area was too much for her resources, she had the courage to reduce.

We like her plan of a standard row width for all her outdoor crops, so that cultivations can be carried out without having to change the width of tractor wheels and tool bars for each crop. This is a lesson all must learn if they are to mechanise economically.

It is interesting to read of how she makes money out of salads, vegetables, bedding plants, cut flowers, pot plants, tomatoes, cucumbers and melons. One wonders where the author found room for it all; this may explain the word 'unlimited' in the title.

If the book is to be used as a reference book, there is one serious error which might lead beginners astray and a few other points which the author might like to reconsider for a future edition. The serious error is that on page 31: we are informed that 1 oz. of carrot seed is sufficient for one Dutch light. It is sufficient; in fact, it is eight times too much. We want carrots, not mustard and cress. The minor points of criticism are that we

think it would have been better if the author always kept to a record of her own experiences. She tends from time to time to give us other people's experiences or opinions. She also writes of some of her immature experiments, things she is trying out, but has not yet decided whether to adopt as practice. If the space so used could be devoted to more detail as to the manurial programme for various crops, the book would be more useful, *e.g.* the chapter on tomatoes both to produce plants for sale and for fruit production is well done, but beginners would want to know how much farmyard manure and how much fish manure was used. Even the experienced grower would like this information, for we always like to know ' what the other man ' does. Other points are Lord Derby is *not* a dessert apple. We do not like inserting chrysanthemum cuttings in J.I. potting compost, but perhaps because the author has ' green fingers ' her cuttings would grow in anything. The method used for the propagation of rhubarb will horrify most Yorkshire growers of this crop. Finally, we should be afraid of using sodium silenate for the control of chrysanthemum eelworm, especially on a place where vegetables are grown.

G. C. JOHNSON

Land Is What We Make it

By Ernest Manners, with a foreword by Arthur G. Davis. Pp. 256. London. Harrap. 1954. 12s. 6d.

The prominence which has become attached to the problem of increasing agricultural outputs has recently been responsible for the production of a large number of books explaining how yields can be increased and agricultural practices modified to meet changing needs. This book is yet another addition to this long series.

The author comes of several generations of yeomen farmers and was himself until recently engaged in farming in Wiltshire. The book itself is written in a discursive style and contains the distilled and accumulated practical wisdom of some three score years of farming experience. As such it has a great deal of sound instruction to impart about the conduct of the ordinary everyday business of farming under British conditions. The author's instruction on such matters as breeding and selling cattle, growing corn, hay making and the making and selling of butter, cheese and milk is very sound and practical and throughout is underlain by a very welcome substratum of common sense.

The book should be useful to the everyday farmer and to the smallholder. It will also have an appeal to the ordinary country-dweller.

Reports and Publications

The Cawthron Institute, New Zealand. Report for 1953-54

The year 1953-54 was noteworthy in the history of the Cawthron Institute in as much as during that year the institute was visited by His Royal Highness the Duke of Edinburgh.

During the year the work of the institute was concerned with a number of problems associated with general farming in New Zealand, particularly with the culture of fruit, hops, tobacco and tomatoes.

Work in connection with soil and vegetation surveys, as always, had a large share of attention. During the year the survey of the soils of the Nelson district in regard to their content of molybdenum was completed; the results show that in many places the soils are definitely low in this element, while some derived from the ultra-basic rocks of eastern mountains are outstandingly deficient, suggesting that they would benefit from molybdenum applications.

The studies of trace element deficiencies in pastures and fruit as well as in hops and tobacco have been continued. Once again molybdenum has been found to be very low and in some cases definite results were obtained from the use of molybdenum salts.

Attention has also been devoted to the distribution of boron in different parts of different crops. For example, it was shown that the leaves of hops contain a high percentage of boron.

In regard to tobacco, it was found that chlorobromopropene and Dithane D.14 gave good results in the control of black root-rot in tobacco seedlings. In regard to tomatoes, chloropicrin continued to give satisfactory results for the treatment of glasshouse tomato soils. At the Entomological Research Station good progress was made with a large number of problems, and excellent results have been obtained with DDT for the control of subterranean caterpillars.

The institute experienced difficulties during the year owing to a decrease in the purchasing power of money and the need for increased grants.

Many staff changes took place. It is satisfactory to notice that most of these were overcome. It is also interesting to note the increasing number of senior posts in the institute which are being filled by women.

The institute has acquired over many years now a high reputation for doing excellent work and this was enhanced by the year under review.

Forest Products Statistics—Food and Agriculture Organisation of the United Nations

This is the eighth year book of Forest Products Statistics issued by FAO's Forestry Division and contains information from more than 110 countries for 1953. It contains a large amount of material not previously published, including tables dealing with the production of and trade in minor forest products from forest areas in a large number of countries.

It is stated that FAO are now investigating methods of making the statistical reports more precise, while an attempt is being made to provide guidance to governments in executing minimum programmes of forestry and forest products statistics.

WORLD CROPS

IN OUR NEXT ISSUE new trends in **Lucerne Seed Production in the United States** will be described by Dr. C. de Fellner. John Grindrod will discuss **Sugar in Indonesia,** while the first part of an article on **Agriculture in Turkey** by P. A. Oram and D. K. Jones will appear. There will also be other articles besides the usual features.

FARM MACHINERY

Agricultural 'Air-Tractor'

Resting on the idea that all agricultural aeroplanes in use to date for such work as aerial fertilising, cotton dusting, rice seeding and weed killing are ' conversions ' and correspondingly inefficient because they are not designed for the job, a new ' air-tractor ' has been developed in the United States for these specific purposes.

The prime organisers of the new $250,000 firm, known as Central-Lamson Corp., set up to build production models of the machine are Central Aircraft Inc., of Yakima, Washington, a large-scale aerial spraying and dusting organisation, and Lamson Aircraft Co., of Seattle, Washington, aircraft consulting and design engineers.

Powered by a 450-h.p. Pratt and Whitney ' Wasp Junior ' engine, the prototype craft has roughly the same wing span as a standard Stearman biplane duster, but is somewhat longer and higher than the Stearman. It has flown with a load of 2,500 lb. and the final version may carry up to 3,000 lb. of dust or spray. Performance with a 2,500-lb. load is: take-off, 990 ft.; landing run (loaded), 950 ft.; rate of climb, 450 f.p.m. (temperature 50°F., wind 0-2 m.p.h., altitude of field 1,070 ft.).

Unusual features of this special-purpose ' air-tractor ' are: spill plates on wingtips increase lifting efficiency, make more even spray-dust distribution; high-lift airfoil section (wood and fabric for easy in-the-field maintenance), with all wings identical so that one spare fits anywhere, fittings on each end; gull section to increase forward visibility while dusting; instruments mounted in gull in pilot's line of vision, easily visible without lowering eyes to cockpit; flap-aileron acts as ground-adjustable flap on upper wing, aileron on lower wing, identical and interchangeable; open rear section of fuselage to allow easy cleaning after use of corrosive dusts or sprays, checking of control linkages at a glance; all tail surfaces identical and interchangeable (special hinges cannot be installed incorrectly).

The carrying capacity is equivalent to more than 40 cu. ft. of material—dust, seed or fertiliser—or approximately 360 gal. of spray.

It is claimed that the new machine has already aroused a good deal of interest in aerial agricultural circles in the United States and Canada and also in New Zealand and Australia, where aerial top-dressing methods are well developed.

A smaller version of the machine, which would carry roughly 1,500 lb. of material, is being planned for the future.

JOHN GRINDROD

The new ' Air-Tractor ' on test flight. The openwork tail section allows easy cleaning of corrosive chemicals and quick inspection of control linkage

Electric Fencing for Sheep-Folding

The new development of electric fencing for sheep-folding from the Cooper-Stewart Engineering Co. Ltd. offers the farmer mobility. It replaces the permanent or semi-permanent enclosure or fold made of expensive and unwieldy wattle fencing and multiple barbed wire. The Cooper-Stewart fence can be taken down easily and removed and erected in another site. The simple construction, combined with sturdiness, is a paramount point in its design.

The wire used with the Cooper-Stewart sheep-fold is supplied in rolls of 50 yd., 20½ in. high and 14½ gauge, with top and bottom wires of 12½ gauge. The square mesh is hinged at each joint and is said to offer a considerably longer working life than ordinary galvanised nettings.

The intermediate carrying posts are patented and have a built-in insulator, above which the post is ' alive ' like the wire itself. ' Gates ' are provided as required by a simple device made up of ½-in. shapen rod, insulated at top and bottom. These are dropped into lugs conveniently spaced on the end support or corner posts.

Rock Pickers

We have received details of the Bestland rock pickers, which are manufactured by the Self Manufacturing Co., of Twin Falls, Idaho. These rock pickers are hydraulically controlled throughout and the operator never leaves the tractor seat during the entire operation of picking and unloading the rocks. The front castor wheels swivel freely permitting easy turning and backing. These castor wheels follow the contour of the land and hold the spring steel picking tines at constant depth as they skim through the soil picking the small rocks to boulders

The ' Bestland ' rock picker at work

about 650 lb. in weight. Should any soil attempt to collect, the operator simply jerks the hydraulic lever which vibrates the points of the picking tines and the soil leaves at once. Due to the fast hydraulic action, no rocks are lost, it is stated.

When an adequate amount of rocks is accumulated on the tines a hydraulic lever is pulled and the tines raise and deposit the rocks into a 3,000 to 4,000 lb. capacity hopper box. When the hopper box is full, a pull of the hydraulic lever unloads the rocks into a truck. There are six models available with three different unloading heights.

Field Chopper

A new multi-purpose field chopper and stalk cutter has been developed by the L. H. Schultz Manufacturing Co., Rochelle, Illinois. It consists of a basic unit which is used as a heavy-duty field chopper. The addition of an auger-blower unit quickly and easily completes the machine for forage chopping. This new Schultz field chopper is stated to mow, rake, chop and load in one fast easy operation, and to be the ideal machine to prepare any forage crop for silage and to handle straw and corn stalks for bedding.

The field chopper with auger and blower unit removed becomes a stalk cutter. It pulverises corn stalks, cotton stalks, bean vines, potato vines, straw brush or any other crop residue and turns it into mulch for new seedings. The manufacturer states that it is excellent for reclaiming brush land, as the efficient chopping action leaves no sharp stubs to puncture tyres or injure stock.

Hammers can be set to desired cutting height: down to ground level or up to 6 in. or more above ground. Cutting height is adjusted hydraulically or with hand lever. Cut is 76½ in. wide. Rotor can be equipped to make a straight, level cut or to contour cut on and between hilled-up rows.

The field chopper can also be used as a mower and is ideal for pasture control and renovation mowing. The mulched residue helps attain a higher producing pasture at the same time it destroys the weeds. Adjustable cutting height to suit any pasture needs.

Caterpillar Horse-power Ratings

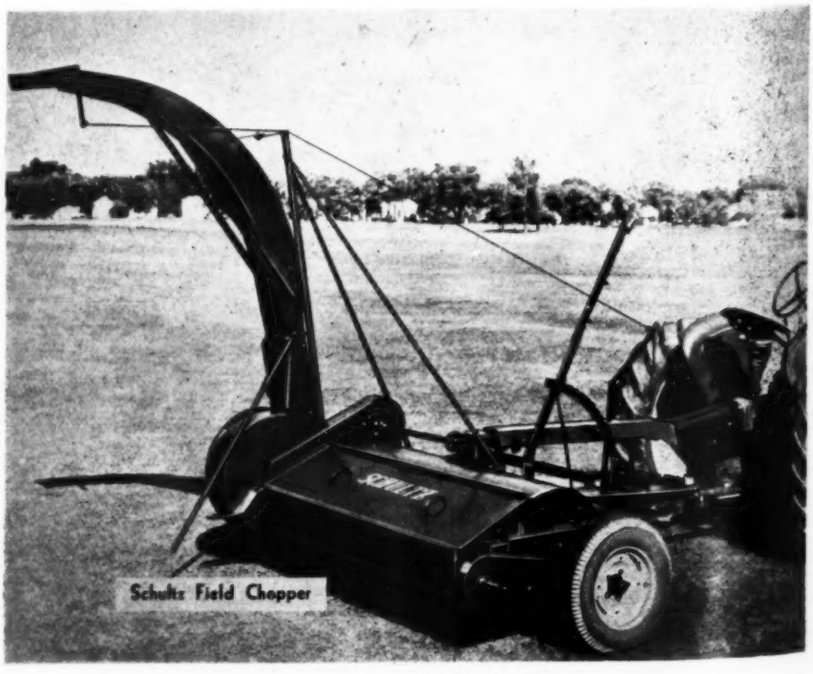
Recent engineering developments at Caterpillar Tractor Co. have resulted in an increase of horse-power ratings for the company's D397, D386, D375 and D364 diesel engines. The ' continuous ' ratings of these engines will be up to and including 1,200 r.p.m. The ' intermittent ' curve is now extended to 1,300 r.p.m.

The ' continuous ' and ' intermittent ' horse-power ratings of the four sizes of engines offered as diesel industrial engines are as follows:

	*D*397	*D*386	*D*375	*D*364
1,200 r.p.m. (' continuous ')	h.p.	h.p.	h.p.	h.p.
Without radiator fan	450	360	302	238
With radiator fan ..	430	340	284	220
1,300 r.p.m. (' intermittent ')				
Without radiator fan	520	415	350	275
With radiator fan ..	493	388	328	253

The ' continuous ' ratings of these engines offered as diesel-electric sets are as follows:

	*D*397	*D*386	*D*375	*D*364
1,200 r.p.m.:	kw.	kw.	kw.	kw.
Without radiator fan	315	250	210	165
With radiator fan ..	295	230	200	155
1,000 r.p.m.:				
Without radiator fan	275	215	173	140
With radiator fan ..	265	205	173	135



The new multi-purpose field chopper and stalk cutter

WORLD CROP REPORTS

WORLD

Leaf tobacco production

North America

Production in 1954 is estimated at 2,618 million lb., up about 173 million from 1953 and approximately 6.5% above the 1947-51 average. This is due chiefly to larger output in the United States, Canada, Cuba and the Dominican Republic, but production was increased in all North American countries except Costa Rica, El Salvador, Guatemala and Panama. The greatest increases in acreage were in Canada, Cuba, Honduras and Puerto Rico. The decreases in acreage were small and confined to only Guatemala, El Salvador and Costa Rica, all of which are relatively unimportant tobacco-producing areas. Due primarily to the continuing favourable price and general demand for cigar leaf, production of this kind of tobacco was stimulated in 1954 in tobacco-producing islands of the Caribbean area, particularly Cuba, the Dominican Republic and Puerto Rico.

South America

The estimated production of 472 million lb. for South America in 1954 was only slightly below that of 1953 and was the second highest outturn on record. All the decrease, as compared to 1953, is due to smaller production in Argentina and Paraguay. Output in all except these two countries increased. Production of Bahia cigar in Northern Brazil was well above that of 1953, when output was far below normal due to severe drought conditions during the December 1952 to March 1953 period.

Europe (including the U.S.S.R.)

Production in 1954 is estimated at 1,248 million lb., almost the same as in 1953. Production for the Iron Curtain countries was estimated at 662 million lb. in 1954, about the same as in 1953, although little is known about the exact levels of output in these countries. A large increase of 11 million lb. (almost 25%) in Germany was almost offset by a decline of 10 million lb. in Italy, the latter due chiefly to dry weather. There was a large increase in acreage in Greece, but the rise in output was small due to drought conditions.

Asia

Total production in Asia (excluding Manchuria) in 1954 is estimated at 3,089 million lb., or about 4% above 1953 and over 5% above the 1947-51 average.

There were relatively large declines in output in Turkey and Iran, with small decreases in Cyprus and Ceylon, but output increased in all other countries. There were large increases in production in Pakistan, India, Japan, Korea and Indo-China, with small increases in a number of other areas. Combined production of India and Pakistan is still below the level reported in the 1935-39 period, but much of this may be due to the differences in methods of estimating production. While little is known in regard to China, the most important tobacco-producing country in Asia, it is reported that 1954 tobacco acreage and production were slightly above 1953.

Africa

The estimated production for 1954 is 316.6 million lb., or about the same as in 1953, but this year's outturn is approximately one-quarter above the 1947-51 average of 256.5 million lb. These data indicate the continuation of an upward trend in most African areas.

The largest increases in production were in Southern Rhodesia, Nigeria and Tanganyika (all British territories). Output declined in Algeria, Tunisia, Nyasaland and the Union of South Africa, but in all of these, except the Union of South Africa, the 1954 production was still well above the 1947-51 average. The decline in the Union is believed to be only temporary, as there has been a shift in kinds of leaf reportedly grown and there has not been sufficient seed of the improved varieties to plant the acreages desired in the last two years.

Oceania

The estimated output of 1954 is 12.2 million lb., a rise of 870,000 lb. as compared to 1953. Output increased about 1.44 million lb. in Australia, but declined 570,000 lb. in New Zealand.

Foreign Crops and Markets

Cottonseed production

World production of cottonseed during 1954-55 is tentatively forecast by the U.S. Foreign Agricultural Service at 16.9 million short tons, on the basis of the preliminary estimate of lint production. This volume of seed would represent a decline of 5% from the 1953-54 estimate, now revised to 17.9 million tons, and would be virtually the same as the estimated production of 1952-53.

The anticipated decline from 1953-54 in cottonseed production is due largely to the sharp drop in United States cotton production. Normally, the United States accounts for well over one-third of the world total. China's production also probably is down. With a few exceptions, output in most other important cotton-producing countries of the world is expected to show some increase from last year. Outstanding among these are India, Mexico, Brazil and Egypt.

North American cottonseed production may drop about 16% as a result of the estimated decline in United States production. The Agricultural Marketing Service of the U.S. Department of Agriculture reports that if the ratio of lint to cottonseed for the 1954 crop in the United States is the same as the average for the past five years production of seed would be 5.4 million tons, a decrease of one-fifth from the 1953 crop of 6.7 million tons. Cotton production in the United States declined mainly as a result of acreage restrictions. A large cotton crop was produced in Mexico this year and seed output is expected to increase one-quarter from last year's volume.

Cottonseed production in Asia probably will be slightly less than the outturn from the 1953 crop. China's output is believed to be down substantially —from an estimated 1.8 million tons to around 1.7 million. On the other hand, India's larger cotton acreage resulted in an estimated increase in cottonseed production of 5%. Seed output is placed at 2.2 million tons, compared with 1.2 million last year. In Syria, seed production is expected to be up one-quarter, while some decline is foreseen in Pakistan, Iran and Burma.

A pre-season forecast of South American production shows an increase of possibly 12%, accounted for largely by the expectation of a substantial increase in Brazil and a somewhat larger crop in Peru.

Production in Africa likely will increase possibly 7%, mainly because of the larger cotton crop foreseen in Egypt, the major producer. As a result of the sharp increase in cotton acreage, Egypt's seed production is expected to be up almost 10%.

U.S.A.

Maize production

The 1954 maize crop missed the 3 thousand million bushel level attained in eight of the past 12 years. Production of all corn is estimated at 2,965 million bushels, nearly 3% under average and 7% below last year. Hot, dry weather over much of the south-western corn belt and the South seared maize at the usual time for pollination. This reduced grain yields and led to much acreage being utilised for silage and forage in these areas. Acreage for grain, at 69,084,000, is about 3% under 1953 and production of 2,652 million bushels of grain maize is nearly 8% less. Plantings of 81.9 million acres were slightly above last year and surpassed July expectations.

A total of 79.9 million acres of maize was harvested for all purposes, 1% less than in 1953 and nearly 7% below average. A decrease of over 1.5 million acres from last year in the West North Central and South Atlantic States more than offset small increases in other regions. Of this year's total harvested acreage, 69.1 million acres were harvested for grain, 6.8 million for silage and 4 million cut for forage, hogged down or grazed. In 1953, farmers harvested 71.2 million acres for grain, 5.9 million for silage and 3.5 million for forage and other purposes. Actual abandonment this year slightly exceeded 2 million acres, or 2.5% of the planted acreage. This compares with only 1.4% a year ago.

A final yield of 37.1 bushels per acre is indicated for 1954, slightly higher than the November 1 forecast. Although less than the 39.6 bushels in 1953, it is 1.4 bushels above average. Yields were under last year in all geographic regions except the North Atlantic States. Greatest declines were in the South Central and South-Eastern Sections of the country. Maize was especially hard hit by the hot, dry weather in June and July. Many fields were complete grain failures; others were poorly filled. Pollination was hindered by the long period of extreme heat and intense sunshine during the tasselling period. Missouri corn, with an average yield of only 16.5 bushels per acre, less than one-half average, was probably most severely affected by the midsummer drought, but crops in South Carolina, Georgia, Alabama and Arkansas were also severely damaged. On the other hand, a record high yield of 62 bushels was set in Ohio, and several of the other important Corn Belt States produced yields well above average.

Production in the North Central States—the Corn Belt—reached a little more than 2.4 thousand million bushels, or about 82% of the national crop. This is nearly 6% under 1953. Decreased acreage harvested in the important States of Iowa, Illinois and Nebraska offset minor increases elsewhere in the Belt. Yields were off sharply in the southern part of the area. This combined with the decline from last year of about 4% in harvested acreage led to the lower production. Spring planting weather was generally favourable, but as the season progressed dry weather in the southern part of the area began taking its toll. Maize in a belt across southern parts of Indiana and Illinois, Missouri and south-eastern Kansas was damaged badly, leading to considerably more than the usual acreage being utilised for silage and forage. Late August rains fell over most of the area, but were too late to help a large part of the crop. Most northern areas had favourable fall weather and only a negligible portion of the crop failed to mature properly. Fall rains delayed harvest in a number of the northern States in October. Picking lagged until November, but then ideal weather permitted the bulk of the crop to be harvested by December 1. Ear moisture was low enough in most areas to allow cribbing as soon as harvest got under way.

In addition to general shortages of moisture and high temperatures in the South, several States in the West report some damage due to lack of timely rains. The North-East had ample rainfall, but suffered some loss in harvesting due to heavy rains and wind damage by the October hurricane.

Cargill Crop Bulletin

ENGLAND AND WALES

Agricultural report. Agricultural conditions in England and Wales on January 1, 1955, have been summarised by the Ministry of Agriculture.

Weather conditions. The weather during December was mild and stormy. Rain occurred fairly frequently during the first half of the month and continued into the third week in northern districts. The second half of the month was mainly dry in southern areas. Gales were frequent and heavy thunderstorms occurred in southern districts.

Autumn cultivations and sowing. The wet state of the soil continued to hamper cultivations and sowing; some progress was made on lighter and drier land in the latter part of the month, but work generally was much in arrear. Other field work was also delayed.

Autumn sown crops. Early sown crops of wheat were looking well, but later sowings were germinating slowly and unevenly. Some damage by waterlogging was reported and slugs were troublesome in several areas. Barley was generally satisfactory. Early sowings of oats were healthy, but some later sowings were backward. Rye looked well. Beans were generally healthy, but rather backward in some areas.

Potatoes. In the western half of the country, and particularly in Wales, there are still some potatoes to be lifted, although some progress was made during the month. Those lifted were generally in good condition. Reports on the condition of potatoes in clamps indicated that, on the whole, they were keeping fairly well. In some areas where crops were affected by blight or were clamped in wet conditions some wastage was anticipated.

Sugar beet. Conditions for harvesting sugar beet were unfavourable until the latter part of the month, when better progress was made. Reports from some districts indicated that a considerable proportion of roots remained to be harvested. Dirt tares were high and the sugar content below average.